Compressed Air Magazine

JULY 1959

IN THIS ISSUE

CRANKSHAFTS

ABOUT ASBESTOS

MISSISSIPPI WAR

INDEX AND COVER STORY, PAGE 3

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GM Diesel covers the power spectrum—20 to 1650 H.P. with only 3 cylinder sizes—compared to the 5 to 10 cylinder sizes which other Diesel manufacturers use

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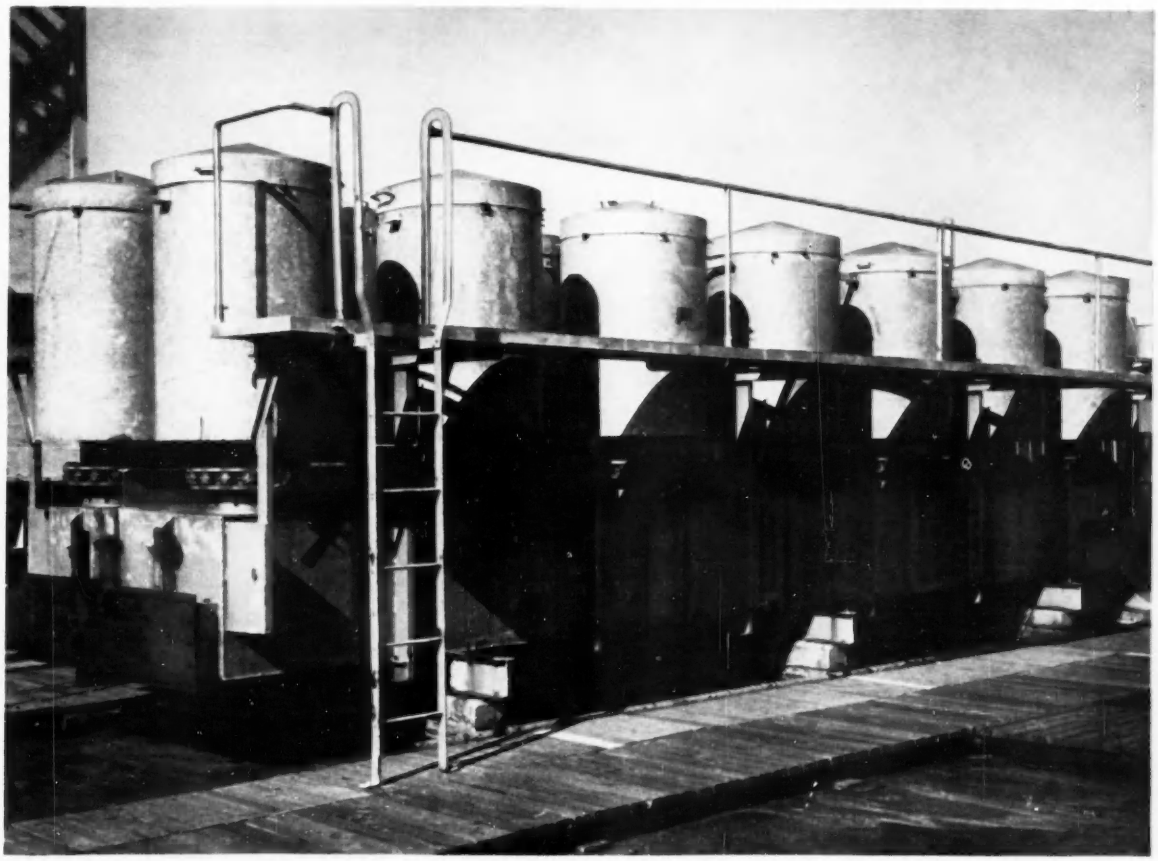

Staynew air-intake filters control intake-processing air at E. R. Squibb Division of Olin Mathieson Chemical Corporation.

Over 10-Year Period . . .

Squibb Finds Staynew Filters Economical, Reliable

Eighteen Staynew Air-Intake Filters, equipped with maximum silencer tubes, filter a total intake capacity of approximately 60,000 cfm at E. R. Squibb Division of Olin Mathieson Chemical Corporation, New Brunswick, N. J.

Air taken in through the filters supplies four low-pressure, centrifugal compressors. Because residences and other Squibb buildings surrounded the installation, quiet intake of air was demanded.

Squibb also specified the filters must be simple and inexpensive, easily maintained, and capable of delivering clean, dry air at absolute minimum pressure drop.

Further, they must handle large quantities of air for the small area occupied, and must be flexibly arranged for partial use during servicing.

This installation has been in operation 10 years. Over that period it has been found economical and reliable, controlling intake-processing air to a degree exceeding Squibb's exacting requirements.

The efficiency of Staynew Filters actually increases with use. Let a Dollinger Representative show you with facts and figures how to save time and money with Staynew Intake Filters.

Write Dollinger Corporation, 7 Centre Park, Rochester 3, N.Y.

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SPECIALIZING IN DRY TYPE FILTERS FOR OVER 35 YEARS

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Whether you need lines for handling water, fresh air or air under pressure, it will pay you to consider the extra performance of this NAYLOR combination.

Write for Bulletin No. 59 for pipe and coupling information.

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Compressed Air Magazine

Founded 1896

VOLUME 64 NUMBER 7 **July 1959**

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OFFICIAL U. S. NAVY PHOTOGRAPH

ON THE COVER

ROCKETS for research might be an apt title for the cover picture. The "forest" of six shown is made up of Nike-Asp units that were fired from aboard the USS *Point Defiance* anchored off Puka Puka island in the South Pacific. Five of the rockets were launched within a span of 40 minutes last year during the solar eclipse and two were in the air during totality. The sixth was fired the following day during a solar flare. Each telemetered radiation information for an average of 8 minutes and carried the sensing equipment to a height of about 150 miles. It was the first use of high altitude rockets for eclipse study, and, at the time, the most successful of shipboard rocket launchings.

FEATURE ARTICLES

Page 10 Crankshafts—*S. M. Parkhill*
To make the largest and most expensive single part of an engine, National Forge uses teams of highly skilled specialists and follows a complex manufacturing process. This article details some of the design and metallurgical problems as well as traces the fabrication steps: forging, machining, hardening and testing.

17 The Story of Asbestos, Part I—*Peter Sleight*
Subtitled "Nature's Greatest Anomaly," this first of a 2-part series describes how the mineral was formed, of what it is composed, where it is found and how it is used.

20 War Against The Mississippi—*Clee Woods*
The struggle to keep Old Man River in its banks has been a long one. Now, concrete revetments, mass-produced in special yards, are helping to do the job quickly and efficiently.

22 Meat Packer's Compressors
Steam-driven air compressors replaced a Ball unit. They operate at a higher efficiency than the former compressor, but require less than half the space.

26 Gas Chamber for Insects
Wrapping a house in a tarpaulin and filling the "tent" with methyl bromide gas kills bugs without allowing the noxious fumes to escape to atmosphere.

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by Ingersoll-Rand

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covering all major
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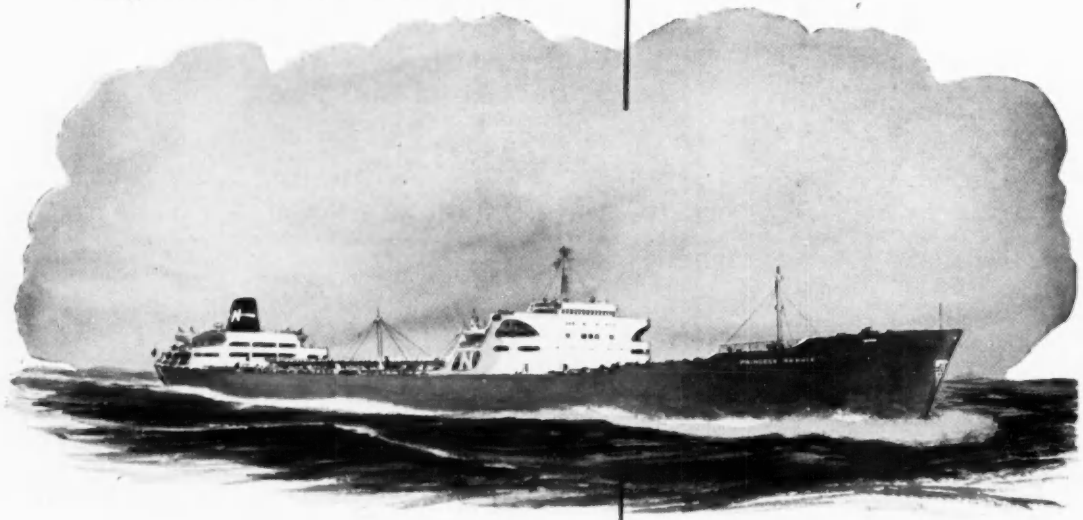

MAIN BOILER-FEED PUMPS	**3 I-R Class 2CNTAM-4** horizontal multi-stage diffusor type.
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WATER SERVICE PUMPS	**3 I-R Class RVS-15**, horizontal single-stage close coupled.
SANITARY PUMPS	**2 I-R Class RVH-15**, horizontal single-stage close coupled.

Also one I-R Type 20S4X Salvage Air compressor, 150 cfm at 30 psig discharge, and two I-R Type 15TX Ship Stores Air Compressors, each rated 60 cfm at 125 psig.

For dependability and economy, select service-proved I-R marine equipment. Ask your I-R engineer for complete information.

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COMPRESSORS • GAS & DIESEL ENGINES • PUMPS • AIR & ELECTRIC TOOLS • CONDENSERS • VACUUM EQUIPMENT • ROCK DRILLS

Flood-Control Tunnel on the Gila

Drill steel supplier: Brunner & Lay Co. of Los Angeles, Inc.; Drill steel reconditioner: D. W. Jaquay Co.; General contractor: Mittry Construction Co.

Using Bethlehem Hollow Drill Steel, this crew is drilling a blasting pattern for a 975-ft long, 25-ft diameter outlet tunnel, which is part of the Painted Rock Dam Flood Control Project on the Gila River, near Phoenix, Arizona. Under the direction of the U. S. Army Corps of Engineers, this project will provide protection against flash floods for some 300,000 acres of irrigated farm land, and will have a net storage capacity of 2,291,700 acre-feet.

Bethlehem Hollow Drill is Economical

In any type of rock removal job, you can count on economical blast patterns with Bethlehem Hollow Drill. Tough and fatigue-resistant, it has a uniformly round hole, and a wide quenching range. And it's easy to heat-treat so that you get the proper balance of toughness and wear-resistance for strong threads and shanks.

Be sure to specify Bethlehem Hollow for all your rock drilling work. You can obtain it in Carbon and Ultra-Alloy grades in rounds, hexagons, and quarter-octagons, and in lengths from 18 ft to 27 ft. Longer lengths can also be supplied.

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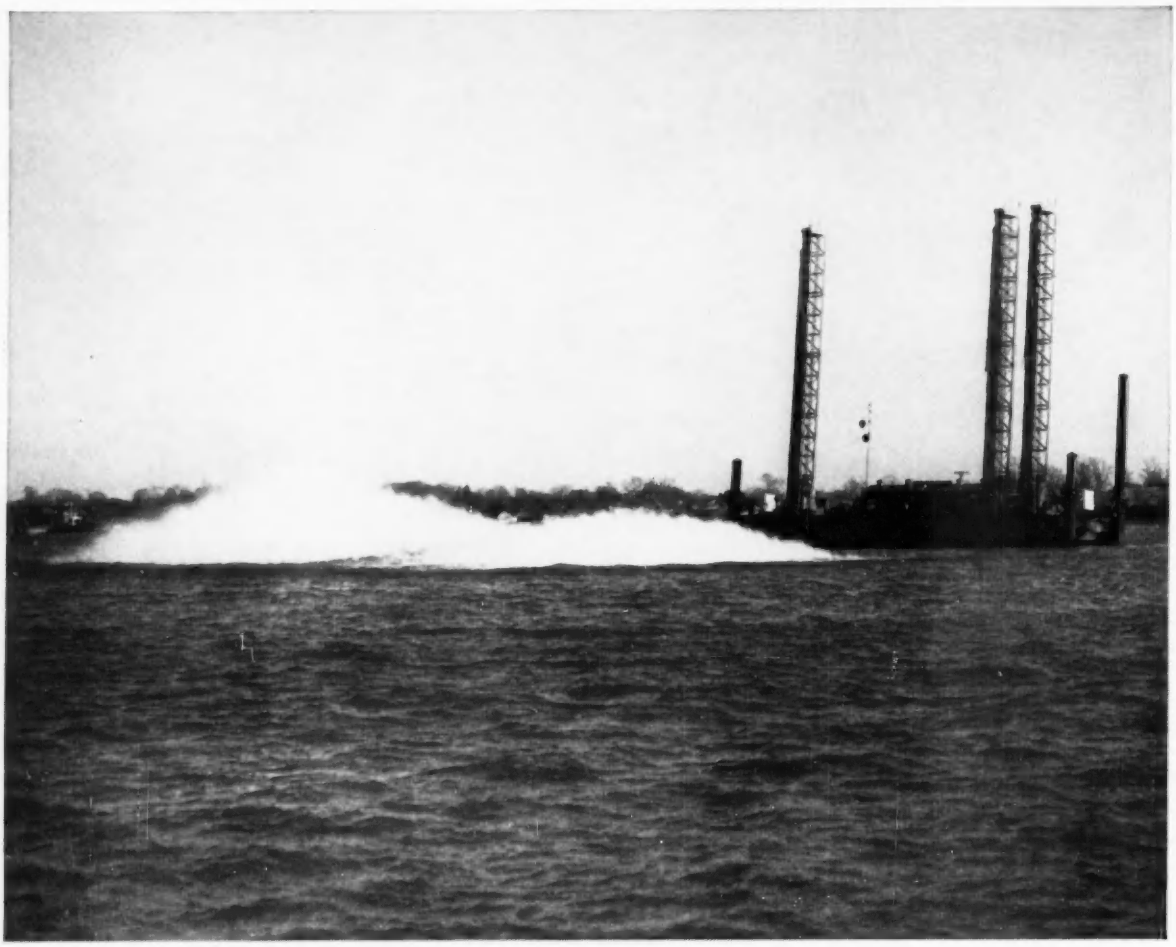

HERCULES PACKS A PUNCH

Blasting rock at six fathoms to deepen a river channel requires dynamite with a punch and resistance to water pressure. Hercules® High-Pressure Gelatin has been endorsed by contractors everywhere for use where the going is tough.

For nearly half a century, Hercules has pioneered in the development of quality blasting materials, including special explosives for special conditions. Included is a group of explosives that have a high rate of detonation under the pressures encountered in submarine blasting.

Extensive research refinements, and up-to-the-minute knowledge of field conditions have enabled Hercules to produce the right explosives for your individual problem. No matter how tough or rugged the job, Hercules explosives will do the job efficiently and economically.

Hercules technical representatives are available to help you choose the most effective and the most economical explosive for your next job.

Explosives Department

HERCULES POWDER COMPANY

INCORPORATED

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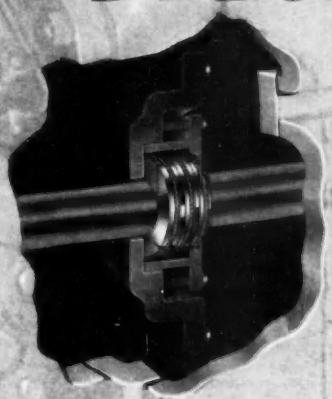

Garlock metal scraper rings prevent leakage, excessive oil consumption

Garlock Style #4400 Scraper Rings allow an exact coating of oil on the shaft . . . return excess to the crankcase. Design benefits are many—*two* scraping edges add greater scraping efficiency, special drain holes relieve pressure buildup, balanced bearing areas prevent "tipping" of the ring.

All rings have a surface finish of less than 10 micro-inches . . . are flat within light band readings . . . come in cast iron, bronze, barium bronze, babbitt, carbon, TEFLON*.

Scraper rings are part of a complete line of Garlock Metal Packings for positive sealing on pumps, engines, and compressors. Designed for the toughest applications, Garlock metal packings are presently handling temperatures as high as +800°F and pressures to 35,000 psi.

Metal packings and scraper rings are more of the Garlock 2,000 . . . two thousand different styles of packings, gaskets, and seals for every need. Consult your local Garlock representative for more information, or write

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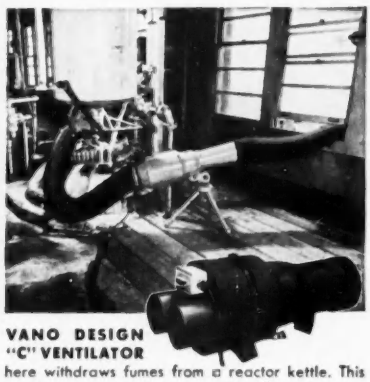
COPPUS "BLUE RIBBON" VENTILATORS

Used in wide variety of applications throughout industry

Improve workers' safety . . . health . . . comfort . . . efficiency

VANO DESIGN "A" VENTILATOR is used here during repairs to a chemical still. This type ventilator is used to ventilate tanks, tank cars, drums, vats, underground cable manholes, pipe galleries, airplane wing compartments, fuselages and other confined places. Uses 8" diameter flexible canvas tubing ("Ventube").

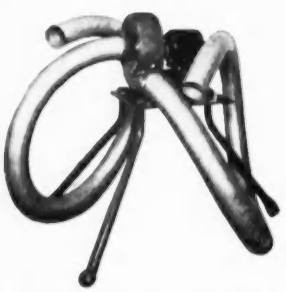
VANO DESIGN "B" VENTILATOR here discharges welding fumes from double-bottom compartment in naval vessel under construction. Large volume of air handled quickly expels fumes and results in good ventilation. Vano Design "B" can pass through opening only 14" in diameter. Uses 8" diameter flexible canvas tubing ("Ventube").



VANO DESIGN "C" VENTILATOR here withdraws fumes from a reactor kettle. This ventilator can be furnished with 8" suction inlet for 8" non-collapsible suction tubing — or multiple inlet nozzles for 5", 4", and 3" suction hose. The discharge may be connected to 8" "Ventube." Capacities furnished on request.

NO. 2 AEROPLANE HEAT KILLER here directs cool, fresh air on worker in drop forge plant. Heat killers restore workers' efficiency by providing extra ventilation in the hot months, or on any job where workers are continually or periodically required to work in excessive heat. Available in two types, three sizes in each.

VENTAIR DESIGN TE-4 VENTILATOR Gasoline Engine Driven, here delivers air into underground manhole. These ventilators provide fresh air to men in confined places, promoting safety, comfort, and increasing efficiency. Ideal where no electric current is available. Delivers 1700 CFM of fresh air. Uses 8" diameter flexible canvas tubing ("Ventube").



PORTAIR NO. 4 BLOWER EXHAUSTER exhausts fumes resulting from soldering, welding, tank coating, is also used in ventilating small tanks. It is designed to permit attachment of 4" flexible metal hose. Capacity: 425 CFM free air.

ATTACH THIS COUPON TO YOUR COMPANY LETTERHEAD

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Please send me information on supplying fresh air to men working:

- ☐ in tanks, tank cars, drums, etc.
- ☐ in underground cable manholes
- ☐ in aeroplane fusilages, wings, etc.
- ☐ on coke ovens
- ☐ on steam-heated rubber processes
- ☐ on boiler repair jobs

COOLING:

- ☐ motors, generators, switchboards
- ☐ wires and sheets
- ☐ general man cooling
- ☐ around cracking stills
- ☐ exhausting welding fumes
- ☐ stirring up stagnant air wherever men are working or material is drying
- ☐ drying of walls, sheets, etc., after treated with coating material

Name .....

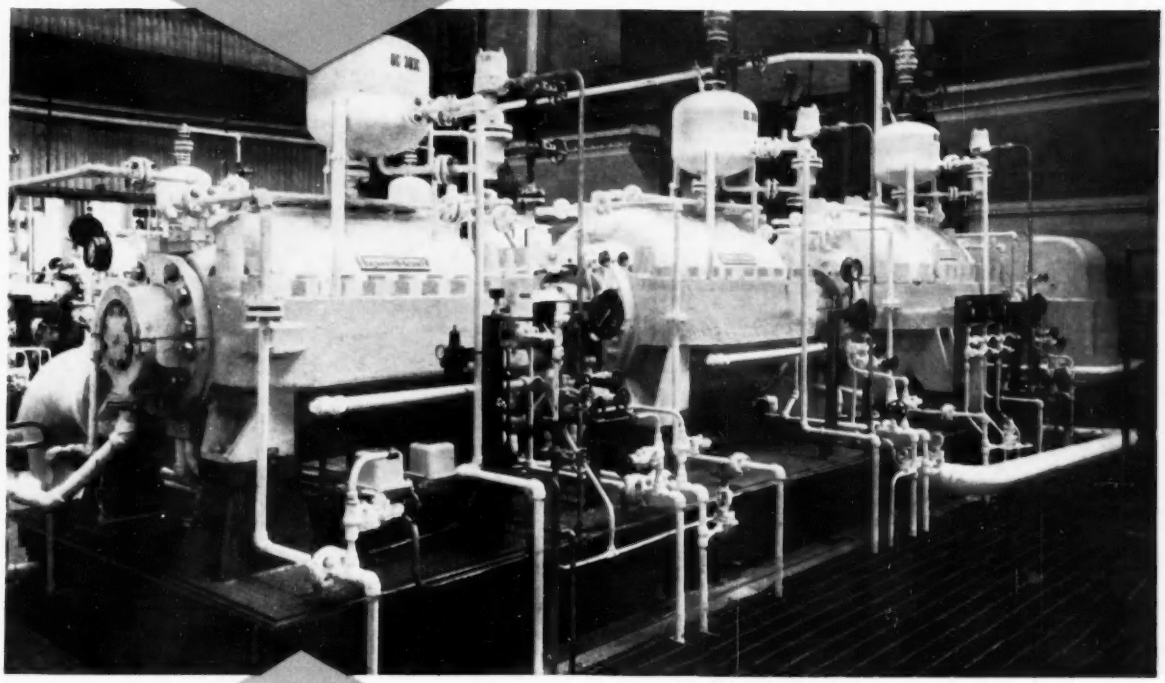
Company .....

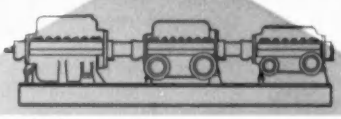
Address .....

City .....Zone....State.....

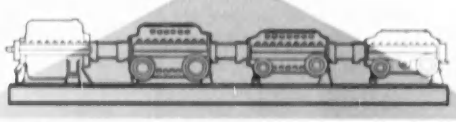
Write here any special ventilating problem you may have { _____ _____

Putting the PRESSURE on Ethylene Production...

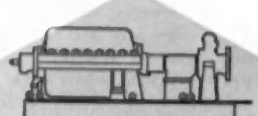




Ethylene Refrigeration: Three multi-stage, horizontally split I-R centrifugal compressors, handling ethylene gas at 396 psig discharge, driven by 12,150 hp gas turbine.



Feed Gas: Four multi-stage, horizontally split I-R centrifugal units compressing 10,750 cfm of hydrocarbon feed gas to 525 psig discharge, driven by 12,150 hp gas turbine.



Propylene Refrigeration: One single-stage vertically split and one multi-stage horizontally split I-R centrifugal compressor handling 17,900 cfm at 265 psig discharge, driven by 12,150 hp gas turbine.

Three Trains of Ingersoll-Rand Centrifugal Compressors help P.C.I. boost ethylene output at Lake Charles plant

THE new plant of Petroleum Chemicals, Inc., at Lake Charles, La., can produce one hundred thousand tons of ethylene per year, making it one of the country's major sources of this vital component for the chemical and plastics industries. Built by the Lummus Company, this P.C.I. plant features the latest technology and equipment for ethylene production.

To handle the various pressures required, nine Ingersoll-Rand centrifugal compressors are installed in three trains, each with its own gas turbine drive. The installation for ethylene refrigeration, shown in the photo above, consists of three multi-stage, horizontally split centrifugal compressors. This and the other two multiple-unit installations, all under one roof, are diagramed at the left. All of these centrifugals are designed to permit a 50% increase in plant production.

P.C.I. facilities at Lake Charles and the adjoining Calcasieu Chemical Corporation's plant (built and operated by P.C.I.) also include two other I-R centrifugals, eleven I-R reciprocating compressors totaling more than 23,000 hp, two I-R Axi-compressors and ninety-two I-R centrifugal pumps.

For information on equipment best suited to *your* compression requirements—centrifugal, reciprocating, axial-flow rotary or ejector—contact your nearest I-R engineer. Sizes and types range from vacuums of 5 microns to discharge pressures of 35,000 psi.

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COMPRESSORS • GAS & DIESEL ENGINES • PUMPS • AIR & ELECTRIC TOOLS • CONDENSERS • VACUUM EQUIPMENT • ROCK DRILLS

Empirical design, skillful forging and precision machining are required for tough—

CRANKSHAFTS

S. M. PARKHILL

LARGEST and most expensive of all the moving parts of an engine is the crankshaft. The art of crankshaft design has developed slowly, but methodically, from the knowledge of simple beams supported at two or more points. Each step forward is based on an accumulation of facts derived from a predecessor model. Of all, multithrow shafts are the most complicated with their geometric angularity.

A typical multithrow crankshaft is that incorporated in a gas engine used in pipeline transmission, gas gathering and distribution service, chemical and gas refineries and the like. In many respects, it is similar to that in an automobile. In all aspects, it represents the sum of design engineering described on page 14. Such a gas engine crankshaft is in Ingersoll-Rand Company's 4-cycle KVG.

The KVG crankshaft is of 1-piece construction. It is forged of electric-furnace steel and is heat-treated to achieve maximum mechanical properties. Because the KVG is of V-angle design, the shaft is thick and yet short in length, giving it the rigidity to reduce torsional vibration during operation.

In the industries utilizing KVG units, down time is expensive. It is, therefore, understandable that the manufacturer spends considerable time in drawing up initial specifications, and that it selects shaft suppliers having excellent reputations. One of these is National Forge Company.

National Forge has a history which extends more than 40 years, but one that tells a story of progress based on integrity and precision manufacturing. It was in 1914 that Clinton E. Wilder, Sr., then a superintendent in an Erie, Pa., machine shop, formed a partnership with Fred J. McCoy and Frank Gillespie—the former being a machinery salesman; and the latter, an owner-operator of a small machine shop. Their venture began with the manufacturing of a metal-cutting core drill, an invention of Wilder's.

Prosperity and expansion followed, and a new building was purchased to house some lightweight forging equipment. With this addition, the necessity of purchasing small forged parts was eliminated, and the basis for the company's present slogan—*Who forges the tough ones? & machines them, too*—was born. Gillespie's interests were bought by the other partners at about this time. In April 1917, a 2-building facility—Irvine Steel Forge at Irvine, Warren

A COMPANY GROWS

The aerial view (left) shows National Forge Company's facilities at Irvine, Warren County, Pa. The administration offices are in the small building at the right. In the grouped buildings to its left are the fabricating shops, beginning with the melting and forging areas on the right and progressing to testing and shipping departments at the far left. The illustration above is of the first shop when the business was moved in 1917 to Irvine, by its founder, Clinton E. Wilder. It formed the nucleus about which the present, more than 7½-acre plant grew.

MELTING

All crankshafts at National Forge Company begin their processing in basic electric furnaces such as the one shown here. Alloying of the steel is done directly in the furnace, rather than in a ladle. The company has three of these Heroult-type units with capacities of 4, 10 and 20 tons.

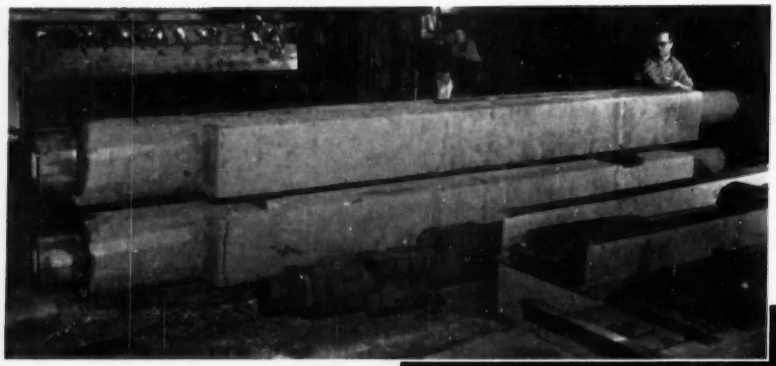
PRESS FORGING

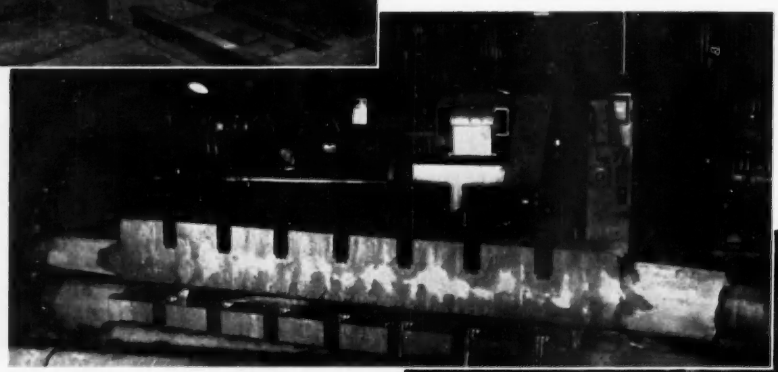
The illustration above shows a hydraulic forging press making the first pass at a 48-inch ingot. The dark portion on the steel is the cooler scale, an iron oxide formed during the heating of the ingot. Its removal amounts to about 5 percent of the original ingot. The man standing at the left, behind the shield, is the forge operator who controls the movement of the press.

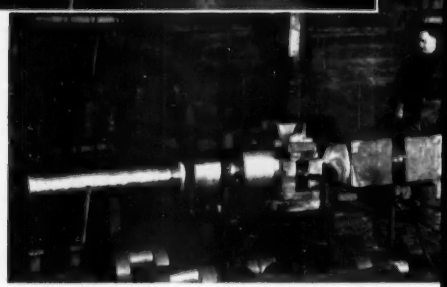
County, Pa., not far from Erie—was purchased and formed the nucleus of the present shops. National Forge & Tool Company, as the new partnership was called, had a roster of 25 men, and its equipment included several lathes, a small forging hammer and a variety of other machining equipment.

With the entry of the United States into the First World War, the making of war material stimulated the forging industry. (Even in the Dark Ages, when all progress lay dormant, the craft of the forger advanced rapidly to keep pace with the needs of war lords.) During 1917 and 1918, National Forge added heat-treating facilities and equipped itself for government work. By 1926, McCoy's interests were sold to Wilder, and a year later, the company name was changed to National Forge & Ordnance Company to more nearly indicate the type of work that was being done. Today, the company is known as the National Forge Company, ordnance work representing a small amount of the total business at this time. Presently, the company is owned by two sons of the founder, and its stock is closely held. Its employment records indicate more than 1000 workers, including chemists, metallurgists, engineers, forging specialists, highly skilled machinists and laboratory technicians—all with diverse backgrounds and long experience in the working of metal.

THE FABRICATION of a crankshaft begins with the melting of steel and its alloying in basic electric furnaces. Alloys can be more precisely compounded, and cleanliness maintained at a higher level in this type of furnace. Alloying can be done in the furnace, rather than in the ladle, which results in a more homogeneous steel. Further, since electricity is used, no impurities from combustion can enter the metal. National Forge utilizes three Heroult-type units with capacities of 4, 10 and 20 tons. In most cases, KVG specifications indicate the use of electric-furnace steel for the many advantages it offers.







There is another advantage of electric-furnace steel that does not appear until later in the manufacturing operations: the results of heat-treatment can be more accurately estimated. The steel may be subjected to a higher-degree of heat without injury in forging.

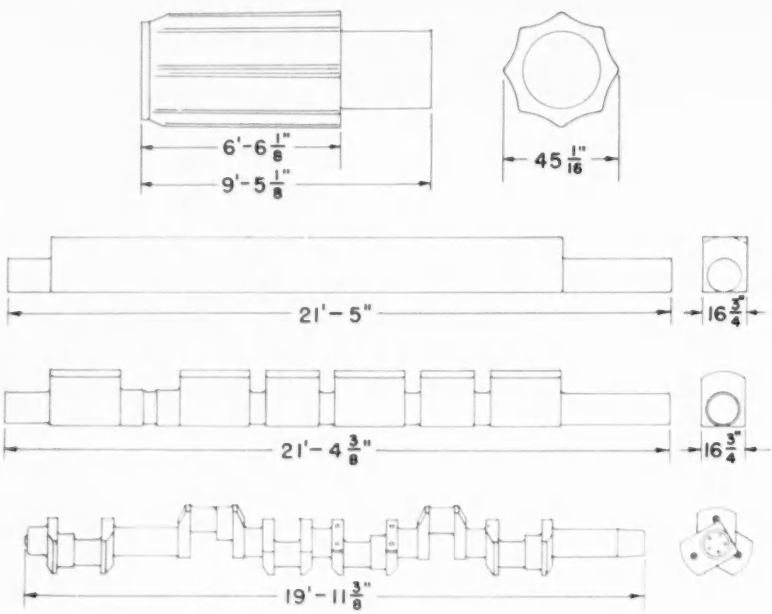
Throughout the shops at the National Forge Company, compressed air is used for many and varied processes. It is furnished by two horizontal, Ingersoll-Rand XRE compressors, electrically driven by 2300-v, 60-cycle Westinghouse synchronous motors rated at 200 and 140 hp. One of the XRE units has cylinders of 19½&12x12; and the other is of 17&10½x12-inch size.

Metallurgy

During the alloying process, close control is maintained over the melting. Samples are constantly checked in the laboratory until specifications are met. The steel is then transferred to ladles, and carefully poured into long, fluted ingot molds. Care must be taken not to stop the stream of liquid, for if it is, the ingot will not be homogeneous, and the subsequent pressure and impacts of the forges may break the steel at the point where the flow was interrupted.

Ingots poured at National Forge weigh between 3 and 34 tons, and range in size from 17 to 56 inches in diameter. After each has been poured, the upper portion is covered with insulating material to prevent rapid and excessive heat loss. The freezing of the metal is much like that of an ice cube, that is, the first crystals form along the outside, and proceed towards the center. These outside crystals are called chill crystals and form at right angles to the wall of the mold. They grow in a dendritic, or pine-tree, pattern towards the center, the growing portions being called columnar crystals. This is a slow process, and to achieve the best results, an ingot must be slowly cooled for many hours.

As soon as it has become sufficiently hard, but while still hot, it is moved to the forging presses. This eliminates extensive reheating before forging.



TO FORGE A CRANKSHAFT

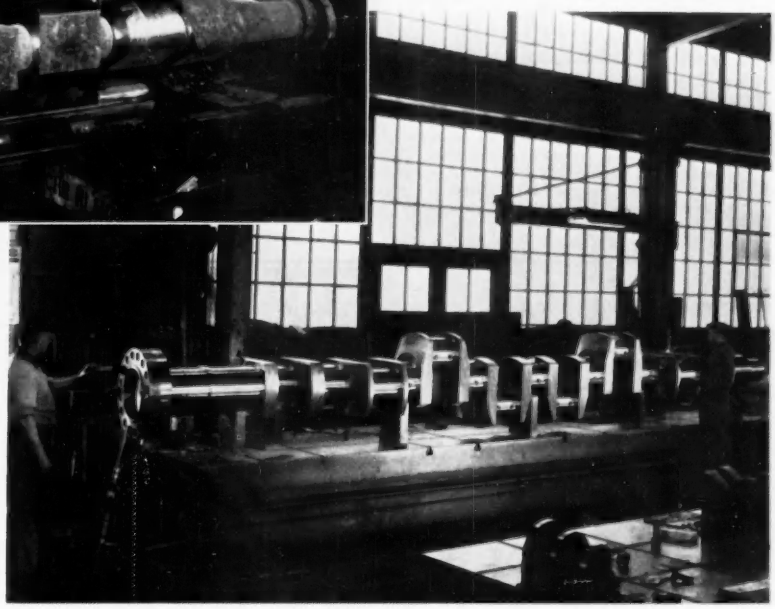
The line drawings above show some of the stages in forming a crankshaft from a crude, fluted ingot (top). The second illustration shows the ingot partially formed into a slab; the third, after having been necked out, ready for twisting the webs; and finally, after the webs have been twisted into their proper position.

Forging

The company has a 1250-ton press and several hammers ranging from 1500 to 8000 pounds capacity to do the forging

PROCESSING A CRANKSHAFT

Turning from the schematic drawing, at the bottom of the preceding page to the actual photographs taken at National Forge Company during the formation of a crankshaft, reproduced across the top of these two pages, a typical shaft after it has been slab forged can be seen. Opposite, and left, is the crankshaft after it has been necked out for rough turn and twisting. Those portions of the shaft that are left standing between the removed sections become the throws and the untouched portion, along the bottom of the workpiece, becomes the main shaft. It is then locally reheated for twisting (center). The end to the left is securely fastened, and intense air-and-oil heat is applied. The opposite end is twisted by means of an overhead crane pulling up on the twisting lever that can be seen at the right. Any decarburization is removed during a further rough-turning operation. The last step for a crankshaft is the finishing and inspecting operation (below, right). This is done after it has been ground and polished.



operations. Five men work around the press and a sixth operates an overhead crane, giving support to the long ingot. Two of the group work the heat, that is, they stand the closest to the press to manipulate the ingot with the help of the crane. A third member, the forge operator, works a control panel from a shielded area. The remaining two keep close watch over the work, giving hand signals—the best way of communication in the shop noise—to the forge operator and the craneman. These men rotate jobs so that no two are consistently subjected to the heat.

Preparing an ingot for a crankshaft is known as slab forging—a squaring and elongating process. With the first pass of the press, the scale, an iron oxide formation formed in the heating of the ingot, falls. Its removal can amount to a loss of about 5 percent of the original ingot. National Forge removes a quantity of more than 5 percent to assure a more perfect steel and one in which the scale is not pressed into the ingot. Such rough material would considerably shorten the service life of the machine tools used in later operations.

During forging, the metal flows under the impact pressure, outward and away from a point that represents the center of the shape. The greatest movement is at the areas of least resistance, represented in the case of slab forging, by the narrower sides of the rectangle; in effect, the metal seeks a circular shape. By constant turning and flattening of the ingot, the rectangular slab required for the crankshaft is produced.

Understanding this flow tendency, it is possible to carefully control the grain direction of the finished piece. In ingot form, these grains have no specific direction; the strength of the casting is approximately uniform in all directions. Forging elongates these grains in the direction of work. As with grains of wood, the greatest strength of forged steel lies along the length of the grains, not across them. Although there is little difference in tensile strength between the directions under test conditions, the with-grain direction proves stronger under service shocks and vibrations.

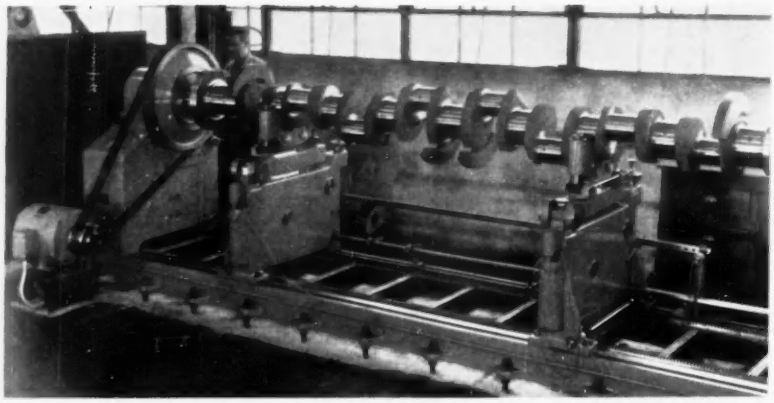
This knowledge of the granular direction is also important during heat-treating. The fiber structure of the forging contains unequal stresses; heat-treatment tends to balance them. The changes that take place tend to warp the piece, altering not only the hardness of the metal, but its physical shape as well. This can be eliminated in some instances, corrected in others.

The forging is ready for initial machining after annealing. Because heat-treating improves the machineability of the forging, there is an even pressure along tool cutting edges. Thus, tools do not need to be replaced as frequently, and high-speed, steady working is possible. This is not true to the same extent with castings.

Machining

Machining begins with necking-out operations. Large rectangular sections are cut into the slab at predesignated intervals. The remaining metal along the bottom of the piece becomes the main shaft, and that which stands above becomes the throws. This operation is illustrated in the drawing on page 12.

The rough crankshaft is then locally reheated for twisting. One end of the slab is placed in a floor-mounted vice; the other is free to turn. A necked-out section is then local · reheated, and the



DYNAMIC BALANCING

The illustration above is of an American-Trebel dynamic balancing machine that is used in the dynamic balancing of crankshafts. It has a capacity of 16 feet and/or 13,000 pounds. Planes at the end and throughout the length of the shaft are checked. This is only one of many means for verifying the trueness and accuracy of the finished product, thus assuring customer satisfaction and ultimate excellence of machine performance and reliability.

free end of the shaft twisted until the proper angle for the crankpin and web is attained. Each throw is individually formed in this manner.

From the twisting operation, the crank is rough-machined on a lathe, great cuts being taken across the entire surface. Any decarburization that encases the slab as a result of the heat and the oxidizing atmosphere, is removed. This amounts to another 5-percent metal loss. As with the removal of the scale, it assures a cleaner shaft.

At first glance, it would seem that such excessive metal removal would be needlessly expensive; for forging, in general, has developed so that close tolerances can be maintained. The statement that the amount of stock trimmed from the final forging directly reflects the over-all operation cost, is basically true. In the case of National Forge, however, the removed metal is not lost, but is carefully collected, sorted and

Formulas, Rules and Theories

CRANKSHAFTS transform a reciprocating motion to a rotary one, or vice versa. They may have side (overhung) cranks, center cranks or a combination of the two. The number of cranks, or throws, depends on the over-all design and function of the machine. In the case of an engine, the angularity is dependent upon the number of cylinders and cycles. To equalize the period of working strokes so as to derive an even turning moment, a 4-cycle engine has cranks at 360 degrees for two cylinders. Similarly, it has cranks at 240 degrees for three cylinders; 180, for four; 144, for five; 120, for six; and 90, for eight cylinders. In the case of a 2-cycle engine, the cranks are placed at 180, 120, 90, 72 and 60 degrees for two, three, four, five and six cylinders, respectively.

Designs of such mechanisms are based on empirical theories and formulas. Engineers responsible for such work should have not only a technical education, but one supplemented with continued study and reading. Perhaps more important, in view of the nature of the existing knowledge, they must have association and free exchange of ideas with other competent engineers. Sound judgment and wide practical experience round out the picture.

The design of a crankshaft begins with a listing of the known and unknown quantities. Such problems as deadweight forces, frictional resistance and forces resulting from shape can next be analyzed. Then the materials to be used and the stress patterns involved are worked out. Material is selected with a consideration of the proposed form of the shaft, the conditions under which it is to be used, cost and the like. A preliminary drawing is made with dimensions assigned to fit with the surrounding engine parts and, in many cases, to meet the standards set by a group of basic formulas established by various insurance companies.

There are a number of these established insurance company empirical formulas pertaining to the principal dimensions of a shaft. Lloyds' of London's rule, for example, relates the finished diameter to the diameter of the cylinder, the length of the piston stroke and the distance between bearing centers. The relationship is modified by certain Lloyds'-determined constants having to do with the number of cylinders involved, whether the machine in question is to have an overhung crank, etc.

These rules are supplemented with other data derived from observation of crankshaft operation. They include such facts as the natural rate of torsional vibration of a shaft, which increases with the diameter of the shaft and decreases with its length. For example, in high compression engines, great stiffness is required to carry the high loads without the excessive deflection that causes rough engine operation; V-type machines generally require short, stiff crankshafts.

Again stresses are analyzed, and, if necessary, design modifications are made before the final drawings are completed. This analysis is laborious, and the results, only theoretical. Calculations are further complicated by the fact that in an operating engine, bearings wear unevenly, causing the crankshaft to sag. Providing these deflections were known, it would be possible to calculate the stresses involved. However, because of continuing wear and changing loads, it is impossible to even approach a usable solution. Therefore, it has been determined that it is permissible to assume that a crankshaft correctly aligned to begin with, has an axis that lies in a straight line.

Some manufacturers make a model of the proposed shaft in a scale of, say, 1 to 4. It is coated with a brittle substance so as to make the stress and strain patterns evident when the model is subjected to theoretical service. Even with this attention to detail before the plans are finalized, some crankshafts may fail due to overloading, main-bearing misalignment, unevenly worn journals and vibration. Essentially, failures result from progressive fractures which develop at areas of maximum stress concentration where fillets have not been generously provided in these highly stressed areas.

Besides the safety factor of 3-to-4 that is inherent in such standards as Lloyds' rules, devices are often added to prevent excessive whipping and twisting. Most common of these are counterbalances used to oppose the forces of the reciprocating piston-connecting rod-crosshead masses.

FINISHING OPERATIONS

The man in the picture above is polishing bearing surfaces to the proper RMS finishes. He uses a rigid lapping device developed by National Forge to prevent eccentricity and maintain parallelism. Standard bearing surfaces are maintained with a minimum 85-percent blue-box fit and standard surface roughness of less than 10 microinches. The blue boxes are constantly checked (right) against a master gauge to assure their specified tolerances.

marked as to alloy type. This scrap is placed in a storage bin to be used to recharge the electric furnaces.

The crankshaft is now ready for the slow removal of metal and the grinding of the crankpins and the main shaft to the tolerances specified. To assure the proper journal dimensions, roundness, trueness, angularity and parallelism, counterbalances are placed on the rotating shaft throughout the entire operation. The shaft is next polished, constantly controlled with tight-fitting blue boxes. Standard bearing surfaces are maintained with a minimum 85-percent blue-box fit and a standard surface roughness of less than 10 microinches. These blue boxes are checked daily for worn surfaces against master gauges.

Nitriding

Depending upon the requirements of the customer's specifications, the shaft may be nitrided and dynamically balanced.

Nitriding consists of heating the shafts, which are held in a vertical position, in an atmosphere of ammonia gas at approximately 1000°F. At this temperature, nascent nitrogen combines with, and slowly penetrates, the elements in the steel. Since this process does not require a quenching operation, there is little warpage and the crankshaft can be finish-machined before nitriding.

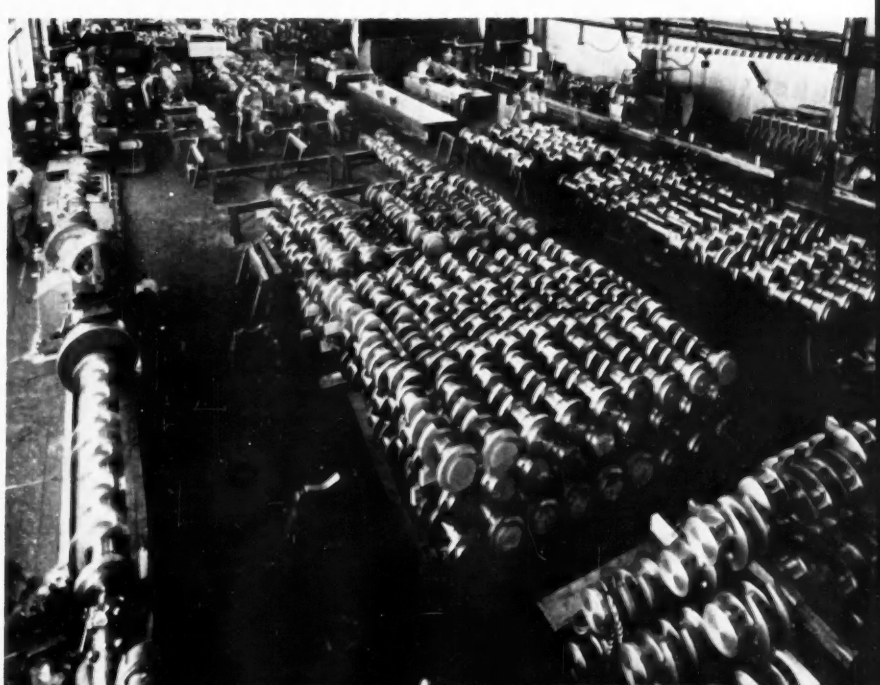
At one time only relatively small steel parts could be nitrided on a mass-production basis. However, with the development of large-capacity furnaces capable of holding 13- and 16-foot-long crankshafts in quantities as great as six for each furnace, even the 120 hours of furnace time required for each treatment has made nitriding economical. Fatigue life of the shaft thus treated is increased, and its strength and wear resistance multiplied, for nitriding imparts a high-compressive case about the surface, normally 0.025 to 0.030 inch of effective depth. When completed, the surface is checked for hardness using superficial hardness testing equipment.

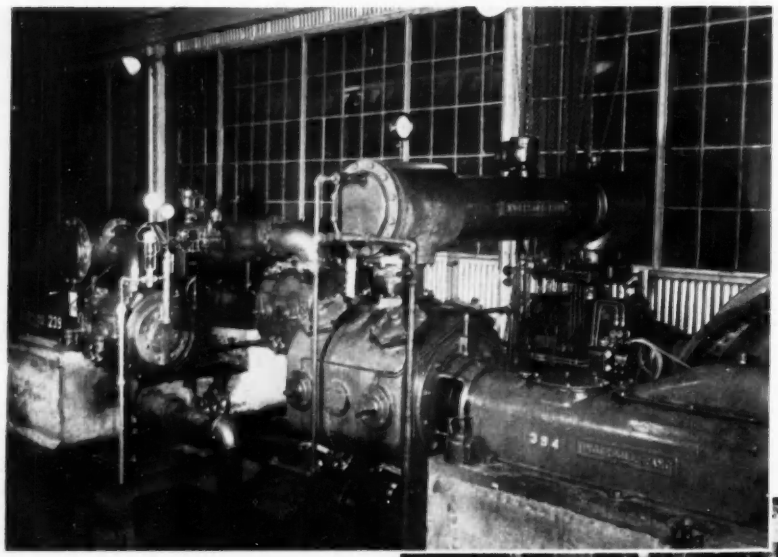
Inspection

After nitriding, the crankshaft may be dynamically balanced in an American-Trebel Company machine having

CRANKSHAFTS IN PROGRESS

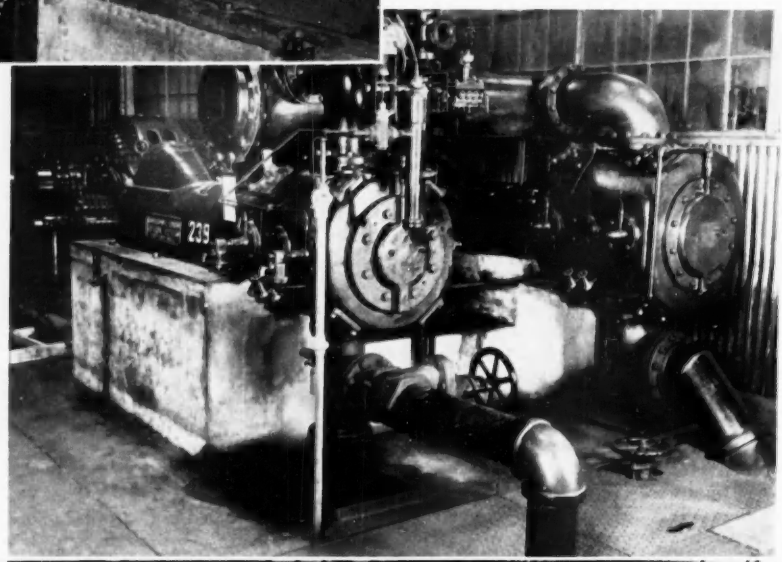
Below is a general view of the crankshaft department at National Forge Company showing the workpieces in process. In addition to the crankshafts, propeller shafts, cylinder liners, rods and platens of all types, mandrels, molds and the like are manufactured at the facility.

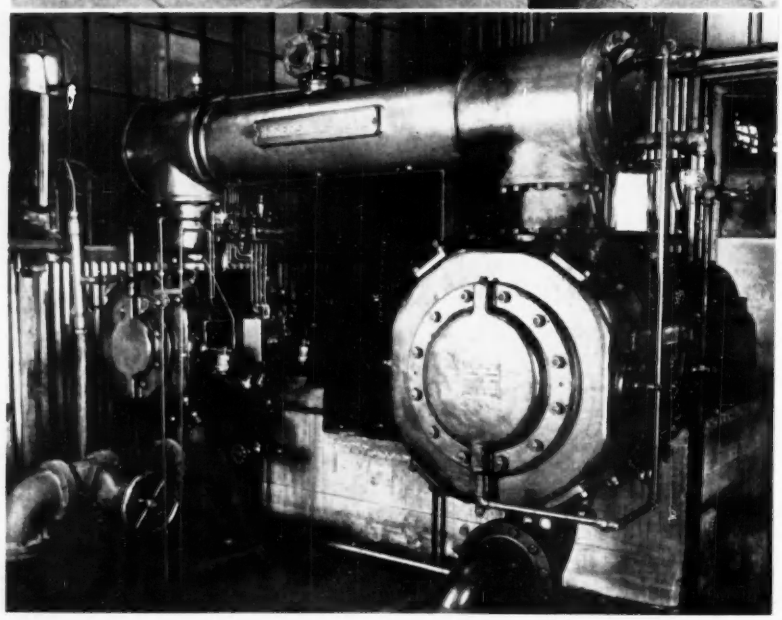




AIR FOR THE PLANT

Air for the many pneumatic applications at National Forge Company is furnished, in the main, by two Ingersoll-Rand compressors (left). Close-up views of the units can be seen below. In the picture directly below, the unit is an XRE of 19½&12x12-inch size. It is driven by a 200-hp, 2300-v, 3-phase, 60-cycle Westinghouse synchronous motor, visible in the rear. The other unit, at the bottom, is a 17&10½x12-inch XRE driven by a 190-hp, 2300-v, 3-phase, 60-cycle electric motor. Both are direct-connected and turn at 300 and 277 rpm, respectively. Each compressor utilizes 5-step clearance control governed by the shop air requirements. Thus the capacities are regulated in five approximately equal steps from no load to full load.





a 33,000-pound, 60-foot capacity. Not only are the end planes checked, but also all the planes throughout the length of the shaft.

The hardness test is but one of the rigid inspection procedures used at National Forge Company. Others include Magnaflux, X-ray, Jominy hardenability, bend, impact, chemical analysis and ultrasonic (supersonic) testing. The latter is a nondestructive method that is used to inspect both solid and hollow objects. Basically, it consists of the transmission of supersonic waves of sound through the material, and the inspection of the reflected waves made visible on a cathode ray oscilloscope. (Waves transmitted through metal are known to travel in straight lines, and are reflected by the opposite limiting surface to the sending crystal. Any internal defects and irregularities, depending on their size and nature, reflect or dissipate all or part of the incident wave.) By this method, internal cracks, voids, nonmetallic particles, segregation and nonhomogeneity are reported. If the trouble is serious enough to fall outside the tolerance limits, the piece is repaired, if possible without violating specifications, or rejected.

When the forging has been completed, a sample of the metal is withdrawn from the piece, marked and sent throughout the operations with the parent shaft. Eventually it forms part of the file that is kept for each crankshaft. On the basis of tests on this and the shaft itself, when requested, a notarized affidavit is sent with each crankshaft stating that the customer specifications have been met and not changed. Thus, if the specifications were correct from the design boards, the shaft will serve not only the machine manufacturer well, but the final customer.

THE STORY OF ASBESTOS, PART I

Nature's Greatest Anomaly

PETER SLEIGHT

ASBESTOS is a mineral form with a seemingly endless variety of properties and uses; its inherent qualities appear to be contradictory. It is even somewhat unique in its highly diversified locations throughout the world and the manner in which it was formed. Asbestos, rarely appearing the same in any two places, even within one mining area, exhibits wide variations in color, fiber length and quality.

The derivation of the word gives a clue to its best known property—fire resistance. It comes from the Greek and means, literally, inconsummable or indestructable. Today, that definition has been expanded, in a sense, for it is known that asbestos is also immune to rot, rust and decay. It even repels most of the ordinary chemicals. There is no fiber, either natural or man-made, that is quite its equivalent.

Early man, with an awe of Nature and her works, came to think of asbestos as a sort of magic fiber. Many tales have passed through the years.

During the eighth century, Charlemagne, host to a party of warriors sent by Harun-al-Rashid, the Caliph of Bagdad, dissuaded them from making war with him by throwing his banquet tablecloth into a nearby fire. When he withdrew it, it was cleaned, but untouched by the flames. It was, of course, made of asbestos; however, the guests were apparently ignorant of the mineral and were impressed. They returned to their city saying that to wage war with so great a magician would be foolhardy.

Marco Polo, in his celebrated travels through Siberia and China in 1275, told of a strange cloth that turned "white as snow" when put in fire, but one that would not burn. He called it Amianthus, a translation of the word asbestos that means unsoiled stone. The mineral he knew probably came from Cyprus.

Plutarch said that wicks for the everburning fires of the Vestal Virgins contained asbestos. Roman shrouds for cremation ceremonies were fabricated of the mineral; and Pliny refers to these death wraps as the "funeral dress of kings." The early Romans obtained their asbestos from the Ural Mountains of Russia and the Italian Alps—two regions that are still producing the mineral. They thought it to be a vegetable formation, and their findings can be seen on display at Vatican City. Apparently, the passage of time has little effect on natural asbestos.

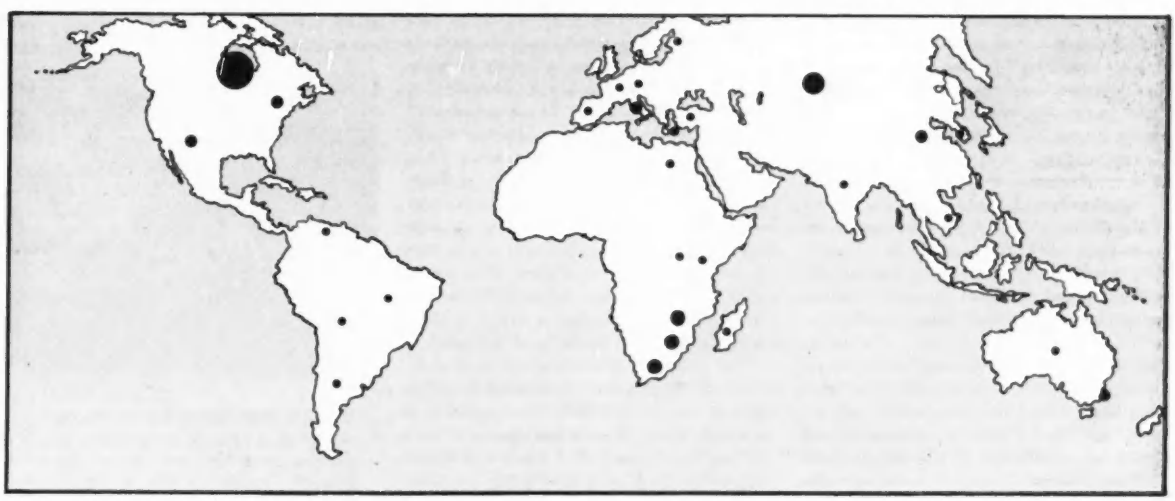
Two of the more unusual uses of asbestos have been its mixture with tobacco for the first really "cool" smoke and as a fabric for the French eighteenth-century ascension balloons.

In more recent history, asbestos has been used for the name of a town in Quebec. When it was learned that the business district stood on an extension of the ore body, its citizens even moved the town for the mineral.

Asbestos is the so-called link between the animal, vegetable and mineral kingdoms, for its characteristics are of each. It is a mineral, yet it can be carded, spun and woven like cotton or wool—*Pierre a Coton*, cotton stone, the French Canadians call it. During its processing, it is lightweight and feathery, but in a natural state, it has the denseness and hardness of the surrounding, or host, rock. As found in the ground, it looks like spun glass; it is smooth and silky to the touch.

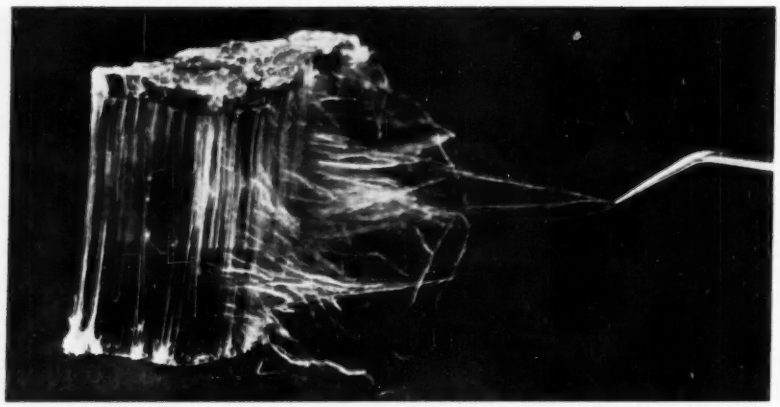
Formation

Asbestos was formed during the Middle Paleozoic Era, but just how is a matter of conjecture. At one time, it is theorized, the serpentine rock that is now found at or near the surface with asbestos, was far below the earth's crust. It appeared as a variety of olivine, called



AROUND THE WORLD

Asbestos outcrops in huge areas in many parts of the world. Some of them are indicated on this map. The size of the various circles indicates the relative importance of each, according to The Asbestos-Cement Products Association.



PHOTO, THE ASBESTOS-CEMENT PRODUCTS ASSOCIATION

TOUGH AND SILKY

Being picked by a small probe, these asbestos fibers illustrate the fluffy nature of the mineral, and at the same time show something of its toughness.

peridotite. This rock was composed of iron, magnesia and silica, and was under great pressure. Mineral-bearing ground waters changed this original rock to a magnesia-silica-water secondary mineral that is called serpentine.

During the metamorphosis, the volume of the rock also increased, causing cracks that soon were filled with intensely hot ground water. Containing carbon dioxide and being under extreme pressure, the water acted as an excellent rock solvent. As it rose in the larger crevices, it lost some of the entrained, dissolved rock, and crystallized with the rock along the sides of the crevices. Dissolved salts and carbon dioxide in the host rock helped it in this process, and the result was a regular crystaline formation. When asbestos is broken apart, this is readily apparent. After the crystalization, great upheavals brought the newly formed serpentine near the earth's surface. Glaciation and weathering scraped away the remaining cover.

The veins, or veinlets, of asbestos are usually less than 2 inches wide, although they occasionally reach 3 to 4 inches. They permeate, without regularity, gigantic areas. Generally, the veins are divided through their centers by seams of magnetic iron ore, reducing by half the total vein width and hence the length of the fiber. (The fibers run across the veins, not with them.) It is thought that these iron ribbons mark the courses of the original cracks in the subterranian peridotite—a fact that helps to substantiate that formation theory. (It is further borne out because the areas immediately adjacent to the veins have also been crystallized to some extent, whereas the rest of the host rock has remained massive. Evidence of the great heat and pressure is found in the igneous instrusions that are common to most asbestos-bearing orebodies.)

This formation theory has been fairly well accepted for the asbestos regions of Canada, Vermont, Arizona, Russia, Cyprus and South Africa. However, some geologists have other opinions. It is justifiable that they should, for there are more than 30 varieties of asbestos minerals found throughout the world. However, only about six of these are of value, and only one (chrysotile) is superior for industrial purposes. It amounts to about 95 percent of the total world production of all natural mineral fibers.

Variations

All varieties of asbestos are fibrous; it is their chemical structure that makes each different. Basically, however, there are three types: (1) crocidolite; (2) amosite; and (3) chrysotile.

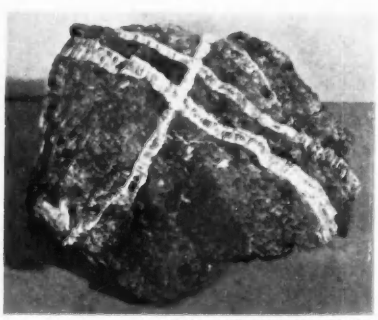
Crocidolite, a fibrous soda amphibole, is technically the only true asbestos. Together with chrysotile, it makes up the most important group of the asbestos minerals. It is a metasilicate of calcium and magnesium (iron), and appears as actinolite or tremolite, in colors varying from white to green-black, although it is generally known as "blue asbestos." First found in 1816 near Orange River in South Africa, it was not until 1831 that the term crocidolite, meaning flaky or woolly stone, was applied to it; and more than a quarter of a century passed before it could be exploited. It is still mined chiefly in Africa and, to a lesser extent, in Australia. Crocidolite is superior for the manufacture of asbestos-cement, chemical filters and the like.

The second variety, amosite, is a fibrous anthophylite that appears as a gray or yellow mineral. Its composition is more than 50-percent silica-ferrous oxide; sodium oxide and water constitute the balance. It was discovered in Central Transvaal in 1907, and was named 11 years later, embodying the first letters of Asbestos Mines Of South Africa, the company most interested in its production. Amosite is valuable in chemical plants because of its excellent acid-resistant qualities; and it was the variety of asbestos that was first spun in quantity in England in 1920 by Cape Asbestos Company.

Chrysotile, the third mineral variety, is a fibrous form of serpentine and is almost invariably associated with it. The serpentine is a commercially worthless, fine-grained, massive rock that is greasy to the touch. Chrysotile is chemically similar to it, being a hydrated silicate of magnesium, consisting of 40- to 42-percent silica, 38- to 48-percent magnesium and 14- to 16-percent water. Its hardness varies from 3 to 3.5, and its specific gravity ranges from 2.3 to 2.6. Chrysotile has an extremely low iron content. Its name was derived from the Greek and means "fibers of gold," the first of the mineral to be found was a deep yellow color. Today it appears white to greenish.

Locations

Asbestos, in its various forms, is principally found in Canada, Africa (notably in Rhodesia and Cape Colony), Russia, the United States (Arizona and Vermont being the best sources), Cyprus, Corsica, Australia, the Italian Alps, Finland and South America. The mining and manufacture of the mineral began on an industrial scale in Italy, the so-called home of the asbestos industry. It was found in Russia in the first decade of the eighteenth century, and Peter the Great established a milling factory there in 1760. Russian production figures are not known today, but evidently the quantity milled is greater than the manufacturing demand, for Russia is beginning to sell asbestos on the European market in competition with the Free World suppliers, notably Canada. There is, of course, no means by which labor rates can be compared, and it is this



PHOTO, THE ASBESTOS-CEMENT PRODUCTS ASSOCIATION

PAY ORE AND HOST ROCK

Three large seams of asbestos stand out clearly in this piece of ore. An indication is also given of the great quantities of rock that must be removed to obtain a small amount of asbestos. The fibers run across the grain, as can be seen, and their length gauges their market value.

presumed difference that is one of the basic reasons for the shift in the market.

Asbestos was not found in Vermont until 1824, and not mined extensively until 1908. Arizona asbestos is known for its electrical resistance because of an exceptionally low iron content. Great Britain's industry began in 1871 with a factory founded by Patent Asbestos Manufacture, Ltd., Glasgow, Scotland. In general, it might be said that although known by the ancients, asbestos did not come into its own until the nineteenth century.

Applications

Asbestos has gained world-wide importance and has developed commercially only with the advance of civilization. During the Dark Ages, little was done with the "magic mineral"; but with the industrial revolution and the rapid increase in technology, the uses for asbestos fibers gained rapidly. Even today, in undeveloped countries, there is little use for the mineral.

The use of asbestos insulation began in 1866. Attempts were made in 1765 to make asbestos paper, but it was not until 1878, in the United States, that the first satisfactory paper was made. Spinning of asbestos began in 1895, and was promoted by Cape Asbestos Company. Ludwig Hatschek, of Austria, introduced asbestos-cement shingles in 1900, and 5 years later it was being made in the U. S. by Keasbey & Mattison Company. In 1906, it was used as brake lining.

The applications are far too numerous to mention completely, but they are generally divided into those that require the fiber to be spun, and those that do not. Included in the first are mailbags, awnings, floor lining in public buildings, oven insulation, automobile footboards, clothing of all types, clutch facings, padding for ironing boards, lining of some prison cells, conveyor belting and fire-fighting shields. Of the shorter fibers, the list would include all those items with which asbestos is mixed, as cement-asbestos, for sidings, protective walling around engine installations, backing for dies, laboratory table tops and the like. Some short fibers are also matted together to make a sort of felt, commonly used for acoustical work, protection of underground pipes, padding in pianos and similiar applications. Raw asbestos is used for rope packing, insulating wire and a compound for encasing of motor windings.

The general uses and markets for asbestos have been constantly enlarging, and a steady growth has been forecast for the next quarter century. Some of the newer products are in the plastics field and its allied industry, that of making molding compounds. It helps to make molding practical by reducing the product cost. Formerly, fillers for molds consisted of sawdust, cotton waste, silica, diatomaceous earth, sand, cork and the like, but each has its own drawbacks. Asbestos, however, especially in the cold-mold process, aids in the control of the flow of the material while under pressure, improves its mechanical properties, decreases mold shrinkage, increases heat and fire resistance, and above all, permits the molds to be moved while uncured without danger of warpage or misshaping. It does, however, add to the weight of the mold and increases its specific gravity, a detriment in the thermoplastics field.

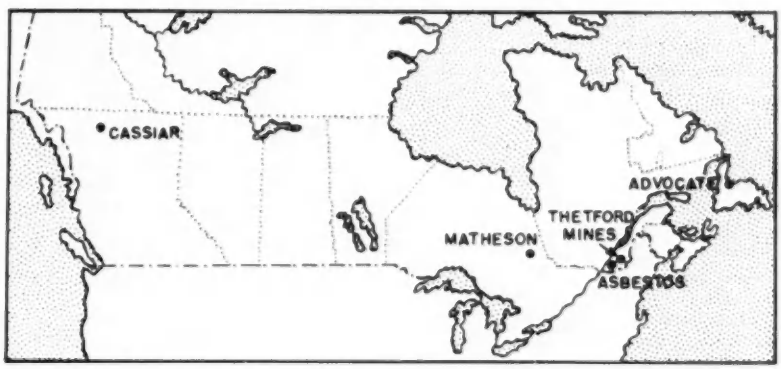
Other new products are being found daily. Kaobestos, a rubber-asbestos material recently introduced by F. D. Farnam Company, Chicago, Ill., is one. Used for gaskets, it is produced by a patented process that separates the asbestos fibers and coats them with rubber, dispersing the whole into a uniform sheet.

With such new applications being developed, Canadian asbestos producers are continually making advances in exploration, while at the same time they are further improving their existing operations. Air power, already being used to a large extent, will become of even more importance, and the need for ever-higher capacities will challenge this already diversified industry.

Next month, COMPRESSED AIR MAGAZINE will summarize some of the current world production statistics, and will look into the mining and milling operation of one of Canada's newer asbestos producers, at Cassiar, B. C.

(To Be Continued)

Canadian Asbestos



CANADA mines chiefly chrysotile. The fibers are noted for their extreme flexibility, fineness and high tensile strength. Individually, they are so delicate that they can only be seen with the aid of a powerful microscope. Small as they are, the most slender has a cross section that is circular or polygonal.

No one has yet isolated a single filament; the smallest thus far measured has a diameter of 0.0000295 inch, and even it is known to be composed of many smaller fibrous filaments. The fibers are strong as steel wire, with a tensile strength of 100,000 pounds, or about twice that of wrought iron. Yet, they feel soft and silky. Chrysotile asbestos melts at 2400° F, and loses its electrical insulating qualities at 1800° F, although it regains them upon cooling.

Legend has it that the Canadian Indians were familiar with asbestos as early as the eighteenth century, although its commercial development dates only from 1876, the year in which great deposits were being worked in Quebec. (It was first discovered near St. Joseph, Que., in 1860.) The first shipment of 70 tons was made in 1878. It had a per-ton-average value of $75. Since then, Canada has played the major role in asbestos production. It is, today, the world's number one producer.

A Committee On Uniform Classification & Grading Of Asbestos Mines Products was formed in 1931 at the suggestion of the Minister of Mines of Quebec Province. The members developed what is known as the Quebec Standard Test, which is still used for classifying fibers for the market.

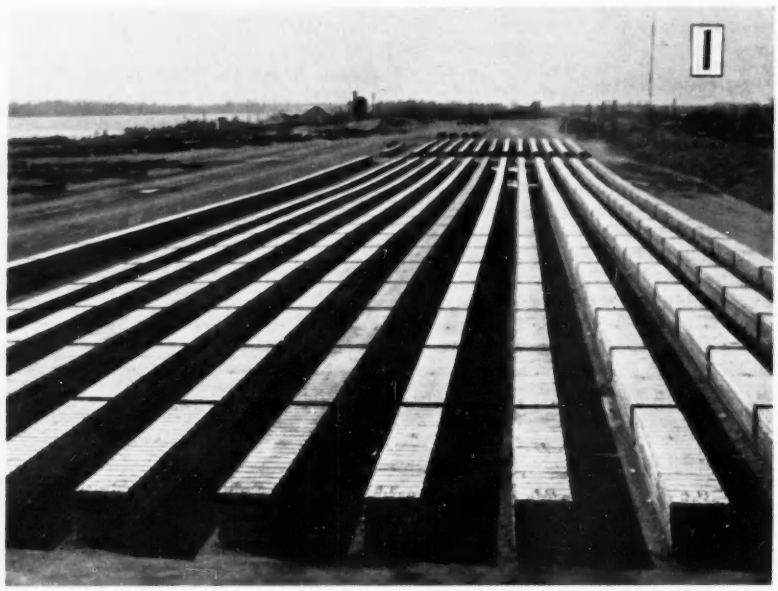
The country is continuing to explore for the mineral, and some of the younger mines, such as the one at Cassiar, B. C., are just beginning to come prominently into the picture a result of improved transportation facilities and mining techniques.

The chief Canadian asbestos areas currently include Matheson, Cassiar, Thetford Mines, Asbestos and Advocate (see map). There are, exclusive of those companies concerned with exploration or development work, eleven directly engaged in the mining of the mineral; and only two of these are outside Quebec, one being in Ontario and the other, in British Columbia.

Concrete Revetments Are Powerful Weapons In—

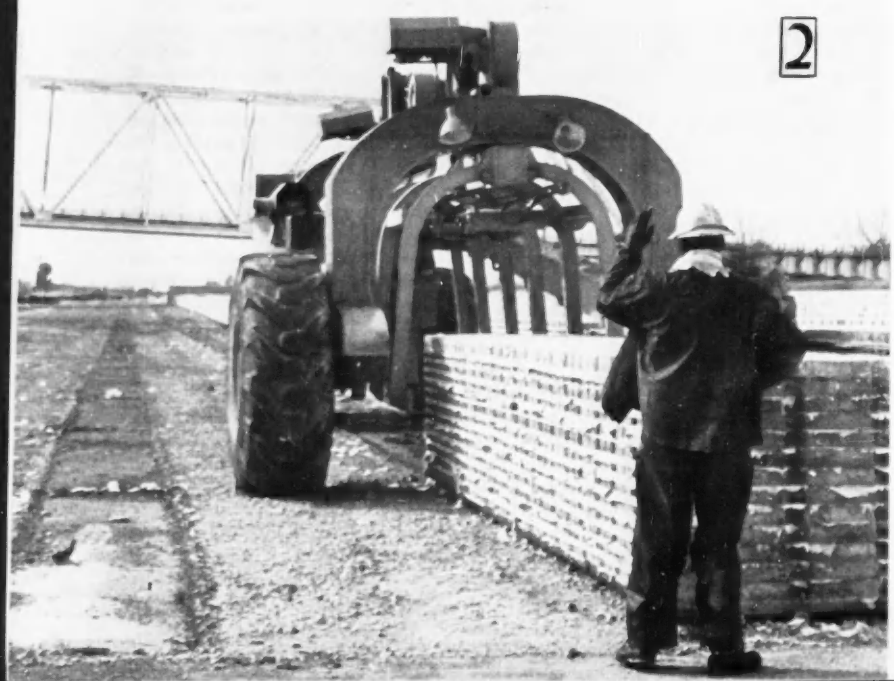
War Against The Mississippi

Clee Woods



ALONG the 270 miles assigned to the Vicksburg (Miss.) District of the U. S. Army Corps of Engineers, nearly 125 miles of modern revetments have been erected to date in the long-term conflict against the Mississippi River. As construction methods have improved during the years, this work has passed through various phases. Today, the once common willow mattresses and other less effective types of stabilizers have given way to the standardized concrete mats. These 4-inch-thick sheets are poured with assembly-line efficiency at three "fields," or large pouring areas, in the Vicksburg District.

One articulated concrete mattress, as they are technically known, is formed by twenty individual concrete blocks held together by copper-covered steel wire. The mats are stored in the fields twelve layers deep, in stacks 3x4x25 feet in size. In *Picture No. 1*, a small portion of the concrete mats in storage at the Vidalia (La.) field can be seen, with the mixing plant in the background.



From the pouring field, giant wagons carry the stacks to a river barge for movement to the levee sites. In moving these large concrete wafers, a wagon first backs astraddle one of the 25-foot-long stacks, as can be seen in *Picture No. 2*. Arms powered by compressed air cylinders are lowered to clamp about the pile and lift their load 8 inches off the ground. Then, much like a mill-yard lumber "straddler," the wagon rumbles down the road to the barge at the river's edge. There is a sharp rush of air as the big steel lifters release their load, and the wagon heads back for another stack. These wagons have their air units mounted on top, near the mid-section.

Designed by Government engineers especially for this task, the unique mat wagon is a combination of specially machined parts and many stock components manufactured by a number of firms. The Vicksburg District has four of the special transporters, which cost $47,000 each. They are moved from job to job by barge for about 6 months each year; high water usually prevents their operation during the remaining months.

When a wagon has deposited a stack at the river's edge, a big barge-mounted crane, utilizing air-motor-driven cables,

picks up the load and swings the stack onto a cargo barge. *Picture No. 3* shows a crane at the Vidalia field lifting one of the 23-ton loads aboard, with the Natchez (Miss.)-Vidalia bridge forming a backdrop. For the complete mat operation, the Corps owns a vast fleet of barges, large and small tugboats, quarter boats and auxiliary equipment. Floating drag lines and barge-based bulldozers are used for clearing the shore prior to placement of the concrete. The number of workers in one complete mat crew consists of about 220 men who are housed and fed on supporting quarterboats.

After loading, many barges are lashed together around a tug, forming a nearly solid floating mass. The tugboat furnishes the power to guide the barges through the swift river currents. A small space is left immediately in front of the boat so that if a bridge pier, another vessel or other large object is accidentally rammed, the tug has space in which to absorb the shock.

The large tugboats push their lashed cargos along the river to the levees in the low country. (No levees are built where banks are naturally steep.) The bulldozers and drag lines go to work smoothing the bank to a 3-to-1 slope, then they grade the bank with gravel at the river's edge. Finally, the prefabricated mats are put in place to line the inside of the levees, as illustrated in *Picture No. 4*, which also shows the large labor crew used. The mats are launched by first edging a mat-laden barge close to the shoreline then backing it out into the stream with tugs. The previously anchored mats slide off the barge into place on the levee. Once in place, the modern structures provide a smooth surface for water flow. They prevent the mighty river from churning and cutting into weak spots where eventually it would spew through to flood adjacent fields and towns.

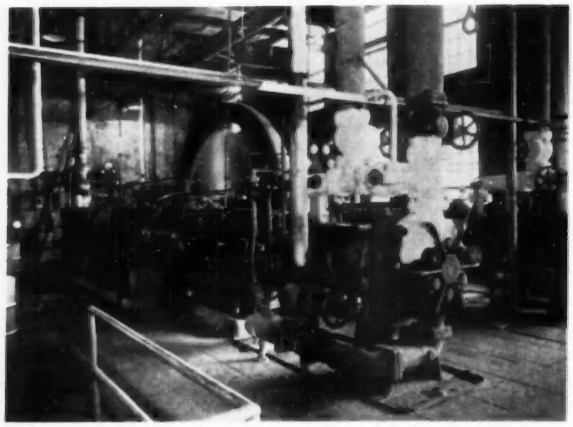
PHOTO, CORPS OF ENGINEERS

"Down On The Levee"

SINCE the inhabitants of the Mississippi basin first settled next to that powerful and dynamic river, a continuous war has been fought to keep her waters within their banks. Many huge meanders have been straightened so that the water might flow more directly to the Gulf of Mexico; diversion projects have been built for sluicing the river away from lowlands and into reservoirs; and for years, dredges have scooped millions of cubic yards of silt and sand from the river bed to keep the channels free.

Yet probably the most sustained effort in controlling the Mississippi has been in the construction of levees. The first ones—puny as they may have been—were thrown up at New Orleans soon after the French founded the city in about 1718. For nearly 200 years, landowners and villagers, from towns near the Gulf to those deep within the interior, fought a futile battle, first alone and later in what was called Levee Districts, using man-made banks to keep Old Man River from plantations and homes. This struggle is reflected in the songs and folklore about the levees—a cultural record that has developed right along with the river itself. Not until 1881 was the first Federal appropriation made to throttle the floodwaters that periodically spill over the river's banks to engulf the nearby lands. The amount was small, however.

After a terrible flood in 1927 left nearly 100,000 homeless, Congress appropriated $325 million for works to be built by the U. S. Army Corps of Engineers. Until that time, the number and heights of the levees had increased only very slowly, but now the job had centralized control and necessary funds. Soon, effective antiflood construction was begun on the 975 miles of river from the confluence of the Ohio and Mississippi rivers at Cairo, Ill., southward to salt water.



OBSOLETE UNIT

A Ball compressor, a refrigerant compressing machine similar to this one, has been removed to provide space for two Ingersoll-Rand steam-driven XPV units in a Swift & Company meat packing plant. The new compressors do more work, more efficiently in the same space.

For Refrigeration And Air—

Meat Packer's Compressors

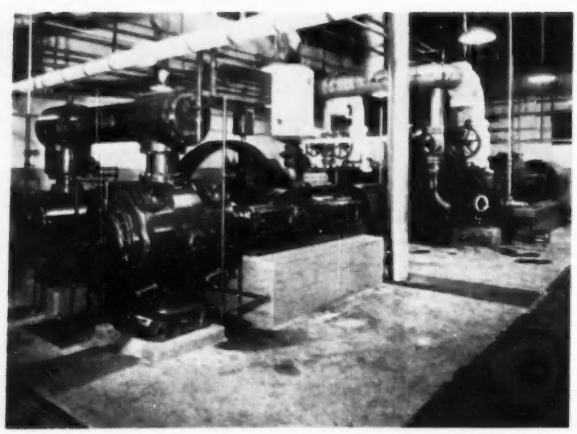
FOR a meat packing plant perhaps no "commodity" involved in the processing operation is more important than efficient and easily controlled refrigeration. It is obvious that a packer's output of meat and meat products, destined for the tables of the world, would be valueless unless refrigeration were constantly available as a means of keeping the processed meats fresh. Chief among the commercial methods for providing this refrigeration is the familiar one of compression and subsequent controlled expansion of gases, mainly ammonia.

Swift & Company, a major packing concern, recently installed three new compressors in the company's South St. Joseph (Mo.) plant; two of these are on ammonia refrigeration service and one is a plant air compressor. The new machines are steam-driven Ingersoll-Rand Type XPV units, with the air unit working at 100-psig and the two refrigerant units supplying an average of 200-psig pressure. Several advantages have resulted in the change from the older to new units, but perhaps most evident is the space savings. The previous unit was a Ball refrigeration type, extremely long with a tall, heavy flywheel. Its shape was space-consuming because of its length and the flywheel's height, and because of the area needed for the large inlet and discharge lines. When this compressor was removed, two of the Ingersoll-Rand units one air and one ammonia compressor were installed easily in the space where the Ball unit had stood. The progress that has been made in recent years in gaining increased output from less space is easily seen. As an example, the new I-R ammonia compressor has five-sixths the capacity of the Ball unit but weighs less than half as much. It needs less than half as much space.

There are other advantages to the new compressors. Operation of them is more economical because the steam rate is better more work is done with the same amount of steam. The modern units, unlike the Ball compressor, can operate for long periods at full or nearly full loads. Maintenance costs are much lower, and the new down-time total is at most less than one-tenth the old one. The Ball unit annually required at least 2 months to be regularly overhauled, and at least once a year it had to be shut down for repairs.

Further, the I-R machines are completely safe. They have forced-feed lubrication throughout, and a switch that stops the compressors should oil pressure fall below a safe operating level. The compressor replaced was lubricated manually by gravity, and according to existing records there was no oil pressure protection device.

The Ingersoll-Rand compressors, their controls and piping, as well as their frames, are more pleasing to the eye and more conveniently designed. These features provide a cleaner and more attractive appearance, and complement the other modern features of the meat packing plant.



NEWLY INSTALLED COMPRESSORS

An Ingersoll-Rand XPV steam-driven air compressor, foreground, and an XPV ammonia refrigerant compressor, right background, were recently installed in Swift & Company's South St. Joseph (Mo.) packing house. They replaced a Ball compressor. As an example of the higher efficiency of the new machines over the old one, the new I-R ammonia compressor alone has five-sixths the capacity once delivered by the Ball unit, but weighs only half as much and occupies less than half the space.

This and That

His Master's Chisel

Canada has adopted a trademark to protect the art carvings of its Eskimo artists. The new emblem depicts an igloo, the Eskimo's traditional home, and the words "Canadian Eskimo Art." Designed to distinguish original Canadian Eskimo art from foreign imports and mass-produced imitations, it is also meant to protect Eskimos from individuals who might attempt to exploit them and sell their work by doubtful means. Only pieces properly bought and paid for will carry the certification mark that appears in two forms: as a sticker and as a tag. The tag also has space for the carver's name, the place of origin and price. Both stickers and labels are applied to the carving where it is produced. An Ottawa artist, James Boyd, designed the symbol which has been registered by the Department of Northern Affairs. Its purpose is to establish the authenticity of the origin of Eskimo carvings (chiefly stone and ivory) and not to judge artistic merit. Such Canadian Eskimo carvings are made at isolated communities throughout the Arctic and their known revenue gained for the Eskimos last year was more than $100,000.

MOBILE WHITTLER

A log barker developed in Canada especially for conditions in North America has mobility as one of its important features. According to the manufacturer, Canadian Ingersoll-Rand Company, Ltd., the unit is "ready to drive right into a wood lot and be at work in minutes." The barking component is mounted on an FC 170 Willys Jeep chassis with 4-wheel drive and heavy-duty springs and shocks. No external power sources are required, making it ideal for remote woodlands operation; one engine drives both the vehicle and the barker. It is the only completely self-contained mobile log barker in quantity production. The new barker also has a safety line that shuts off the feed and drum drive when struck from either side of the unit, protecting the operator as well as guarding against damage to the machine. Low gasoline consumption rate coupled with economies of maintenance give the unit a low total operating cost. The photograph above was taken from the out-feed side and indicates its production efficiency. Production is claimed to be 5 to 8 cords per hour, depending on conditions. Logs 4 to 16 inches in diameter and from 5 to 6 feet long can be handled without using auxiliary feed supports. Feed speeds are adjustable from 50 to 100 feet-per-minute with seven speeds forward and immediate reverse at any speed.

* * *

168-Foot-Long Control Panel To Brazil

What very well may be the largest control panel ever built in the United States for export has been shipped to a Brazilian petroleum refinery. The panel is 168 feet long and contains 24 sections. It will be the control center for the Mataripe refinery that Petreleo Brasileiro is expanding from 5000 to 37,000 gallons per day. Built by Minneapolis-Honeywell, the unit portrays the refinery operations graphically on the instrumented panel by use of flow diagrams in color. With just a glance, operators will be able to tell what is happening at any point in the process. Instrumentation includes a large number of miniaturized pneumatic indicating, recording and controlling devices, electronic potentiometers and flow meters. The panel sections, the largest of which is 18 feet long, will be moved by barge to the refinery, located 10 miles from the seaport of Salvador.

* * *

Professional Engineers To Cooperate

An important step towards the unification of the engineering profession was made recently when the American Society of Mechanical Engineers announced that in the future, members of 21 sister engineering societies will enjoy the privilege of attending general meetings of the ASME without paying registration fees. At conferences sponsored by any of ASME's Professional Divisions, they will pay the same fee as that charged ASME members—one that is usually half of the nonmember rate. The 21 groups are those represented on Engineers Joint Council and Engineers' Council for Professional Development, two organizations dealing with matters of profession-wide interest.

* * *

Exothermic Patching Material

Maintenance of open hearth, electric and similar types of steel-melting furnaces has long presented costly headaches to the steel industry. Holes and cavities that appear in the bottoms and walls of these furnaces must be patched immediately. Present techniques, besides producing comparatively weak patches, involve fusing the patching material at

a temperature high enough to damage the furnace lining itself. They demand a repair time that runs into hours and even days of idle man power and equipment. A new and unique exothermic patching material has been developed for Carb-Rite Corporation by the Armour Research Foundation of the Illinois Institute of Technology. It will generate its own heat to seal the defects in linings of heavy steel-melting furnaces, and completely eliminates the destructive burning-in process presently required. Reports indicate that it effects a strong and permanent patch in less than an hour, thus slashing required repair time by 80 percent.

* * *

Vacuum Melting Furnace

One of the United States' most advanced metal refining furnaces—a consumable electrode vacuum melting furnace—will be produced and sold throughout Europe by Stein & Roubaix, Paris. The unit produces some of the high-alloy supermetals required in the missile, supersonic aircraft and atomic energy fields. The consumable electrode furnace pioneered in titanium melting and made possible the production, in commercial quantities, of vacuum-melted alloys and superalloys. Titanium, zirconium, stainless and high-alloy steels and other ferrous and nonferrous alloys are all remarkably free of impurities when melted in the furnace. The development of the furnace began in 1948 when Allegheny Ludlum Steel Corporation's research on titanium started. Its commercial development was first announced in October 1955. The consumable electrode melting furnace offers such advantages over direct-arc furnace melting as a higher degree of cleanliness, better compositional homogeneity in the metal, improved workability and ingot soundness, and general improvements in mechanical qualities. New applications for metals melted in the furnace are constantly being explored and the future of the process is considered excellent.

* * *

Data Of A Daily Struggle

Here's something to ponder the next time you strangle that final oozing from your tube of toothpaste. During 1958 the number of collapsible tubes that were manufactured to meet such an ignominious end totaled more than 1 billion. These soft metal containers for toothpaste, medical-pharmaceutical products, household and industrial fluids, cosmetics and shaving cream required some 24,416,000 pounds of various metals. The Collapsible Tube Manufacturers Council reports that lead was the most used—13,777,000 pounds. Aluminum was second with 8,196,000 pounds; and tin, third with 1,194,000 pounds. Alloys of tin and lead made up the rest. Dentrifices required the most metal for packaging—5,893,000 pounds of lead, 4,995,000 pounds of aluminum and 64,000 pounds of tin. Household and industrial products ranked second.

* * *

Nuclear Power Competes

Nuclear power has been declared competitive with other types of power to supply electricity to the Humbolt Bay area in Northern California. The Humbolt area is somewhat isolated and is currently supplied by two 110,000-v transmission lines about 115 miles long, a 14,500-kw steam plant and a new 100,000-kw steam plant. According to studies made by two engineers, F. F. Mautz and G. L. Coltrin, who reported their findings at a convention of The American Society of Civil Engineers, the Humbolt area will need additional power by 1962. The two Pacific Gas & Electric Company engineers believe that an atomic unit at the isolated areas will have about the same operating and maintenance costs, exclusive of fuel, as a conventional steam unit. They believe conditions are favorable for a nuclear plant with a capacity of 50,000 to 60,000 kw. Also considered for the Humbolt area, where oil costs are said to be more expensive than elsewhere in the electric concern's system, was a second 115-mile-long transmission line. This, however, was deemed uneconomical. Information for the study came from the power company's experience in operating the Vallecitos nuclear power plant in Alemeda County in the Oakland area. The Vallecitos installation was the first all-private-financed nuclear power plant in the world. On August 31, 1957, the AEC issued it Power Reactor License No. 1.

* * *

Delta-Shaped Designs

Building a Mach 2 jet fighter-bomber such as the U. S. Air Force's F-105 is no 1-man operation and when Republic Aviation Corporation recently totaled up its suppliers for the job, the number came to 3450. Some $75 million worth of contracts went to these firms located in 38 states and the District of Columbia. Of the 3450, 2670 were businesses employing 500 persons or fewer. Even more varied were the 50,000 separate items necessary for fabricating the jet. Needed were materials varying from tiny washers to aluminum sheet to fire control systems. Perhaps most unusual, however, was an order by Republic personnel for soft diapers to polish the jet canopies.

G. W. Morrison Retires

For the first time since 1920 the name of G. W. Morrison is absent from the masthead of COMPRESSED AIR MAGAZINE. He has relinquished his duties as Publisher of this magazine, bringing to an end a career of more than 50 years in the field of compressed air and fluid transfer equipment. Born in Union Mills, Iowa, April 19, 1885, he graduated from Iowa State College and began his career with the J. George Leyner Engineering Company, Littleton, Colo., in 1910. His first position with Compressed Air Magazine Publishing Company in 1920 was as Treasurer. In April 1921, he became Treasurer & General Manager and in November 1932, was elected President. In addition to his other duties, he assumed those of Publisher of this magazine in January 1947. His alma mater, in 1955, presented him with an award for "distinguished service in the field of technical journalism." Again, in 1958, he received an Iowa State College Centennial Award. In May 1959, at the age of 74, he retired as President of Compressed Air Magazine Publishing Company, and on June 1, effective with the current issue, as Publisher. His guidance and direction through the years have in large measure been responsible for the success of COMPRESSED AIR MAGAZINE. An ardent golfer and fisherman all of his life, we wish him continued enjoyment in the pursuit of his hobbies.

G. W. MORRISON

EDITORIAL

Pipeline Progress

PETROLEUM this year celebrates its one hundredth anniversary, counting from the Drake discovery at Titusville, Pa., in 1859. Looking at the myriad facts and figures, some of them astronomical, dealing with the production and refining of petroleum, the mere physical problem of moving these huge quantities of gases and fluids from one place to another is sometimes forgotten.

The nets of pipelines that now crisscross the countryside carry a large portion of crudes and refined petroleum products to market: in the field of natural gas, virtually 100 percent of all used is carried in pipelines. That the industry has played a vital part in the saga of petroleum progress is self-evident for without cheap efficient means of taking oil to where it is needed, the development of many areas of the country might have been considerably different.

PITHOLE was the site of Drake's well. Millers Farm, 5.5 miles away, was a transhipment point and teamsters of 1859 charged $3 per barrel for the haul there from Pithole. In contrast, Texas Eastern Transmission Corporation's recently published tariffs on the Little Big Inch petroleum products pipeline show that the rate to move a barrel of gasoline from Beaumont, Tex., to Chicago, Ill., is but $0.40—less than a penny a gallon. Further, the rate for other refined products is only $0.44 per barrel for the 900-mile journey.

PIPES for petroleum transfer are often attributed to Jacob J. Vandergrift who was, at least, one of the first to visualize the advantages of long stretches of oil piping. By 1875 he and his partners owned a total of 300 miles of line, no one section of it, however, more than 40 miles in length. In November 1878, in Titusville, the Tidewater Pipe Company Limited was formed for the purpose of laying a crude oil line from the Pennsylvania fields to tide water at New York City. By 1887, the line was complete to Bayonne, N. J. (Eventually the pipeline company became the integrated Tidewater Oil Company of today.)

The nation's first compressor station for transmitting natural gas is believed to have been erected at Rixford, Pa., sometime prior to 1885, although the exact date is vague. The relatively low-pressure compressor was a duplex steam-driven unit with steam cylinders of 24-inch diameter and compression cylinders of 26-inch diameter. The stroke was 30 inches. In 1892, the pioneer high-pressure station was placed in service. Located at Greentown, Ind., the equipment was designed to work at 600-psig pressure and to force gas to Chicago, Ill., 120 miles away. An 8-inch pipe was laid to carry the gas. Prior to the installation, gas had been compressed to 700 psig and shipped by rail to the city in large cylinders.

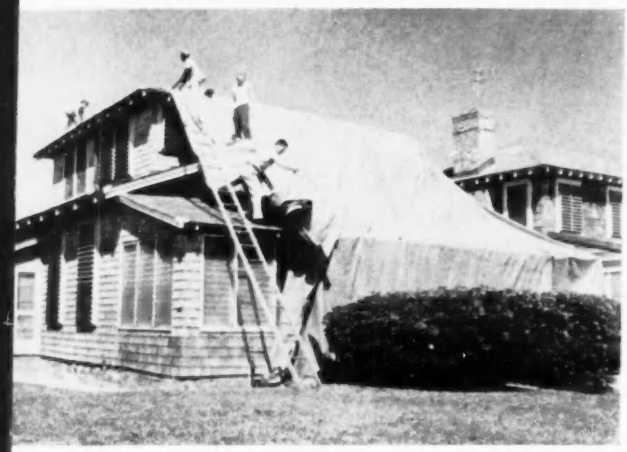
THERE were 90,000 miles of crude oil pipelines in the United States in 1929 when this magazine surveyed the development of pumping stations. It was noted in that story that per-barrel shipping rates ranged from a high of $0.10 per 100 miles to a low of $0.04, or about today's average cost. In that same year was marked the beginning of today's products lines in which refined fluids, rather than just crude oil, are shipped to market. Appropriately enough, perhaps, the first of these was also located in Pennsylvania, the cradle of the industry.

Current statistics show that crude oil lines now aggregate 160,000 miles of piping; that products lines, in the last three decades, have been developed into a network of 45,000 miles and one that handles roughly 20 percent of all U. S. traffic in that category; that natural gas (now supplying about one-quarter of the nation's energy needs) is distributed through a 565,000-mile-long system. The total mileage of all types of lines has been called the most efficient overland transportation scheme ever devised.

IF PIPELINES have come a long way since the 1880's, compressors and pumps have advanced farther. The evolution of the gas-engine compressor, the development of the centrifugal pump, the application of centrifugal compressors are among the most significant events that have made possible the high transportation efficiencies of modern pipelines.

Great advances have been made in the pipeline construction industry. Within the field served by this magazine, rock drills and portable compressors have made great strides and along with other advanced pipeline-laying equipment are in large measure credited with keeping the cost of new construction at a level on which pipelines can compete with other forms of transportation.

Compressed air (and/or gas) control and actuation of valves, regulators and recording equipment have also played a vital role in reducing the manpower required to operate the pipelines. Indeed, the pipeline industry more than almost all others, represents the reliance we place on pumps and compressors for many of our material needs.



WORKMEN SPREAD A VINYL-COVERED NYLON TARPAULIN OVER A HOUSE . . .

THE EDGES OF TWO COVERS ARE ROLLED AND CLIPPED AIRTIGHT . . .

A LAST SEALING CHECK IS MADE AS GAS ENTERS THE SPACE . . .

Gas Chamber For Insects

EACH year many millions of dollars in damage are inflicted by that little-loved class of creatures, insects. As man's battle against the 6-legged pests goes on, one of his foremost tactical problems is learning how to kill the bugs without harming humans and other organisms.

Last summer in Jacksonville, Fla., tests were conducted on a house fumigation technique which permits a home owner to kill insects without releasing dangerous fumes to the atmosphere. Each dwelling in the test was first completely enclosed in a lightweight nylon tarpaulin covered with vinyl, designed by the Tarpaulin & Canvas Goods Company, Indianapolis, Ind. The covering's two materials make it long wearing and resistant to harsh chemicals. After the cover was made airtight about the house, methyl bromide gas stored in tanks at 60- to 100-psig pressure was released inside. The gas blanket was retained for 24 hours so that it would permeate deep into the structure. After the tarpaulin was finally removed, the extermination specialists found the houses to be insect free.

The "tarps" used for these tests were bright red in color to warn of the dangerous fumes. This type of covering is waterproof, nonabsorbent, and resistant to flame, acid and rot. As part of the continuing war against insects, the tarpaulins are also being designed for fumigating industrial buildings, box cars, lumber piles, grain elevators and even crops in the field.

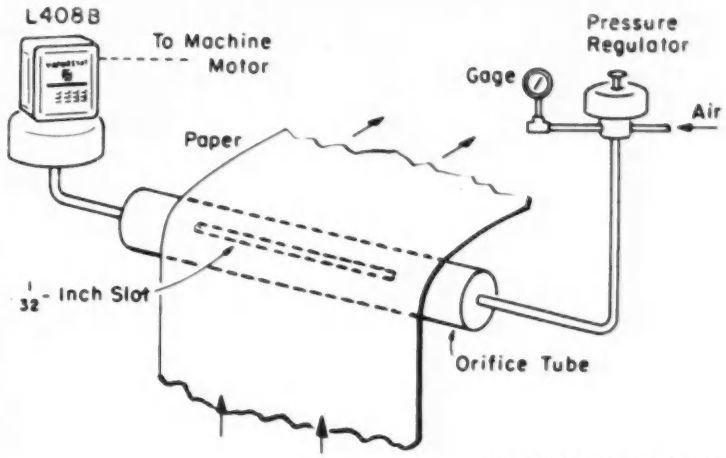
FINALLY, THE HOUSE IS COMPLETELY COVERED AND THE GAS ATTACKS THE PESTS.

Application: Paper Breakage Control

THE Permacel Tape Corporation, New Brunswick, N.J., has developed a means for using a reduction in compressed air pressure to control breaks in paper moving at high speed through a converting machine.

The diagram at the right explains the system. The long sheet of paper is passed over an orifice tube—a slender cylinder that has a 1 32-inch slot cut into its length. Air is fed under constant pressure to the tube, through it, and on to a Minneapolis-Honeywell Regulator Company Vaporstat pressure controller. As long as there is no break in the paper web, it continues to cover the tube slot and hold in the air. The paper moves through the process without interruption. However, when a tear develops, the closure over the slot is lost. Air escapes, pressure drops and the Vaporstat instantly breaks the circuit to the converting machine motor.

This quick and inexpensive method halts the paper's movement before the tear becomes a complete break. A splice repairs the damage and saves a time-consuming rethreading job that would be necessary after a full break. Further, a long wasteful "bird's nest" of unraveled paper is avoided.



PHOTO, INDUSTRIAL CONTROL NEWS

The Minneapolis-Honeywell controller (model L408B) has a bellows-actuated mercury switch that can be set to open or close motor circuits, valves, relays and other devices on such a rise or fall in gas pressure.

Sinking Viking

THE motion picture industry has long been one that spared no expense to simulate reality; yet in recent years increased emphasis has been placed on doing things economically. Recently compressed air came to the fore in providing realism at an economical cost. In the production of the film *The Vikings*, the script called for a sinking of a Viking vessel. Viking ships are expensive items, even in a large budget, therefore it was necessary that the sinking take place but once, thus barring retakes of the film, or that some means be provided to repeatedly salvage the vessel. Accordingly the ship was fitted with air tanks that were flooded to sink her and then charged with air to bring her to the surface again. The savings per retake: one completely outfitted Viking warship.

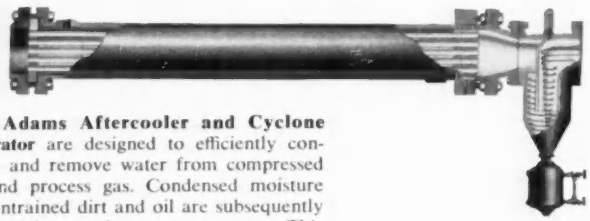
Application: Condenser Assembly

UNIFORM NUT TIGHTENING

Shown here is a workman tightening nuts to a specific torque on a condenser installation. He is using an Ingersoll-Rand 5340-T Air Impactool that allows the operator to select the torque that will be applied to the nuts. Before the use of this Impactool, some nuts were being tightened excessively and others not enough. This resulted in pressure losses, leakage and, in some cases, rejection of the units. The I-R Torque Control Impactool eliminated the guesswork in the heat exchanger manufacturer's operation by making sure that tightness was uniform. The Impactool gave both the desired means for quality control and drastically cut impacting time with its automatic shutoff control feature.

Aftercooler and Cyclone Separator designed for cleaner, dryer compressed air

R. P. ADAMS CO., INC.
209 East Park Drive, Buffalo 17, New York



The Adams Aftercooler and Cyclone Separator are designed to efficiently condense and remove water from compressed air and process gas. Condensed moisture and entrained dirt and oil are subsequently removed in a cyclone type separator. This unit is scientifically designed for maximum removal efficiency over a wide range of flow rates.

For normal use, units are available to cool gases to within 10° F of the temperature of the cooling water. Specially designed units are available to permit a 2° F approach to cooling water temperature, for application where low moisture content is critical.

Adams Aftercoolers and Separators are available from stock to handle 20 - 40,000 cfm with 10° cooling and 25 - 19,200 cfm where it is necessary to cool within 2°F of the cooling water. Special units can be supplied to suit an unlimited range of requirements. In all cases the maximum pressure loss at rated capacities is ½ psi.

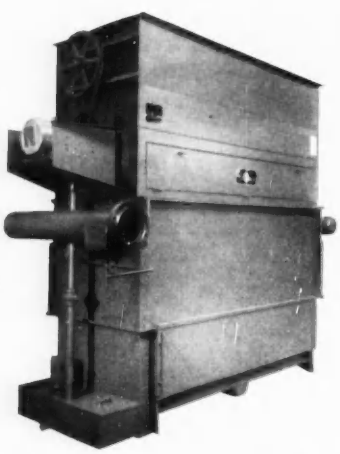
This wide range of sizes enables the economical utilization of Adams Aftercoolers and Separators in virtually all industrial application. For further information on how R. P. Adams' units will solve your compressed air problems and save you money, write today for Bulletin 711.

How to get drier or cooler AIR or GASES

at low cost

NIAGARA *AERO* AFTER COOLER cools a compressed gas, or air, below the temperature of the surrounding atmosphere, thus preventing the condensation of moisture in your lines. The gas will contain only half of the moisture left in it by conventional methods. Even drier gas can be produced if you require it.

In working with controlled atmospheres of inert gases to prevent undesired reactions, this dryness of the gas at low cost is a great advantage. The cost of the Niagara method is low because it uses evaporative cooling, saving 95% of the cost of cooling water (and its piping and pumping). This direct saving of cost pays for the Niagara cooler in less than two years.



If you use compressed air to operate instruments or pneumatic equipment you will get better results by using the Niagara Aero After Cooler.

Write for Bulletin 130, or ask nearest Niagara Engineer if you have a problem involving the industrial use of air.

NIAGARA BLOWER COMPANY
Dept. CA-7, 405 Lexington Ave., New York 17, N. Y.
Niagara District Engineers in Principal Cities of U. S. and Canada

Indus

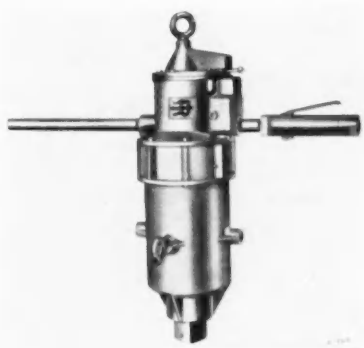
LEAKS in compressed air lines can be located by use of a dauber that applies clear liquid to the line or joint being tested. After the application is made, bubbles will appear within 5 seconds if the line is faulty. It is said that the liquid is convenient to use, requires no mixing and does not form

confusing suds. The dauber-cap bottle shown is a 4-ounce size; pint bottles and gallon containers are also available. *Sprague Devices, Inc.*, Michigan City, Ind.

FOR tightening and removing nuts on bolts from 6 to 12 inches in diameter, Ingersoll-Rand Company has developed a new air Impactool, the Size 599 Super Slugger. The tool reportedly has four times the power of any other wrench on the market. It is expected that its greatest use will be in the manufacturing and maintenance of heavy machinery, such as is found in power generation stations, petroleum installations and in steel mills. Since the tool is handled by a hoist or crane, it has been designed for easy positioning with eye-bolt suspension for either vertical or horizontal

trial Notes

use. According to the manufacturer, Super Slugger eliminates laborious and time consuming manual nut-running methods as well burning, battering and sledging of frozen nuts. It thereby reduces down time, job hazards and fatigue while increasing production and bolstering worker morale. Equipped for 2-man operation, the tool has a reversible motor, and a ball and cam impact mechanism that has proved successful in a broad range of other Impactool



sizes. The Size 599 runs with a free speed of 330 rpm and delivers 500 blows per minute when impacting. It weighs 599 pounds, has an over-all length of 37½ inches, a side-to-center dimension of 7⅞ inches and a nose diameter of 11¾ inches. It is available with heavy duty impact-type sockets and a 3½ inch square socket driver. A description of the Super Slugger is contained in Form 5226. *Ingersoll-Rand Company*, 11 Broadway, New York 4, N. Y.

COMPLETE data of nozzles for industrial spraying applications are contained in a 32-page catalog, No. 59. The table of contents keys nine general types of the units to their applications. Within the booklet, each type is illustrated, showing its spray pattern. Also explained are spray characteristics, construction, materials and nozzle applications. Tables then give various pipe sizes, orifice diameters, and capacities at different spraying pressures. Also contained in the catalog are sections

CUT COSTS WITH THE NEW

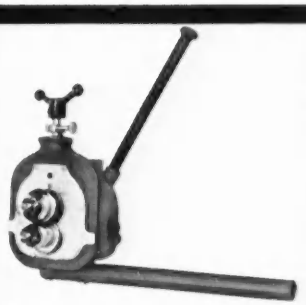
VIC-EASY®

METHOD OF JOINTING LIGHTWEIGHT PIPE

SAVE UP TO 60% IN PIPING COSTS!

Now there's no need to buy overweight pipe. Thanks to Victaulic engineering, you can select lightweight pipe "job-rated" to your conditions and install it the new *VIC-EASY* way. You'll cut costs of pipe, transportation, and handling —you'll save from 30% to 60% in man-hour installation.

1. LIGHTWEIGHT PIPE in thicknesses from .065" handles high pressures. Leading mills make sizes 1¼" to 12", steel or aluminum, with *VIC-EASY roll-grooved ends.*



2. VIC-EASY PORTABLE GROOVER rolls grooves into pipe in seconds. Manually or power-operated, this groover removes no metal...retains full wall thickness.

3. VICTAULIC SNAP-JOINT COUPLING assembles and locks by hand—no wrenches or tools required. Other bolted styles of Victaulic Couplings alternately usable.

4. VICTAULIC FULL-FLOW FITTINGS team up with our couplings and lightweight pipe to provide a *complete VIC-EASY system*...cuts costs of installation *and* operation.

For complete information write for Bulletin BB-7.

VICTAULIC COMPANY OF AMERICA
P.O. BOX 509 • Elizabeth, N. J.

about strainers, nozzles for metal cleaning, pipe friction tables, pipe fitting friction tables and a table giving data on spray coverage. *Wm. Steinen Manufacturing Company*, 45 Bruen Street, Newark 5, N. J.

ALUMINUM usage in heat-exchanger fabrication is described in a publication, *Reynolds Aluminum for Heat Exchangers*. Summarized in its sixteen pages of charts and pictures is technical information needed by heating engineers, fabricators and industrial purchasers. The text treats aluminum heat transfer rates, temperature properties, tensile strengths, pressures and dimensional tolerances. Charts provide fingertip information about aluminum stress values, working pressures, thermal expansion, and conductivity and friction factors. *Reynolds Metals Company*, PRD-2, Box 2346, Richmond, Va.

AN OBSTRUCTIONLESS magnetic flowmeter, designed for metering liquids difficult to handle, is described in a 6-page catalog, 10D1416. Several of these liquids are concentrated acids and alkalis; slurries; paper pulp; waste sludges; sewage; pigment dyes; starch solutions; food products; black liquor; and similar corrosive, abrasive liquids. Principles of operation and advantages of the meter, which will accomodate flows from a fraction of a gallon per minute to many millions of gallons per day, are discussed. *Fisher & Porter Company*, 38 Jacksonville Road, Hatboro, Pa.

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A complete, self contained unit that collects and automatically ejects water and oil from air lines.

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Development Engineer
Ingersoll-Rand Company

Keeps pace with progress . . .

Revised and expanded to reflect the significant advances in recent years in the field of centrifugal pumps, this book provides a modern treatment of the whole field. Includes a method of attack based on: a single pattern of flow; identical theoretical reasoning; and similar design procedure for centrifugal, mixed flow, and axial flow pumps.

Features of the 2nd edition . . .

- New material on centrifugal-jet pump systems
- Important design elements and performance characteristics incorporated in a single chart covering all important design elements
- Chapter on water-hammer problems
- A Concise account of progress in water storage pumps
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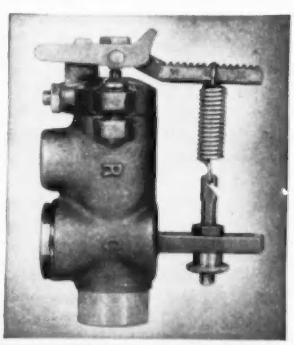
REBUILT UNLOADER VALVE REPLACEMENT SERVICE

Saves . . . ***TIME PRODUCTION PROFITS***



24-hour service . . .
all makes and sizes . . .
new valve guarantee.

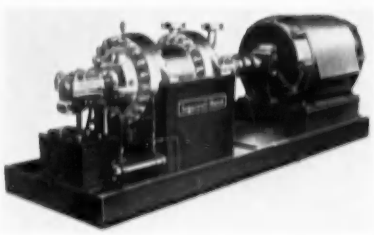
HOW'S YOUR STOCK OF SPARE VALVES?

R. CONRADER CO. INC.

BOX 924 • ERIE, PA.

itary applications are described in a 16-page booklet, Form No. 1100. The publication also defines those circumstances under which direct-writing recording systems provide maximum benefit to users. These devices, which offer the advantages of putting information into written form, are used in standard systems for industrial use, as well as for monitoring military space technology and scientific data. Shown is a broad range of the manufacturer's oscillographs, special-purpose amplifiers and systems. An example of the industrial use of the equipment is that of a tool manufacturer who uses a recording system to learn effects of vibration and heat generated, feed forces and depths of cut on high-speed lathes. *Brush Instruments*, Thirty-seventh and Perkins, Cleveland 14, Ohio.

A BARREL-TYPE pump designed specially for refinery and other high-pressure services has been introduced by Ingersoll-Rand Company. Classed as the CMR charge pump, the unit features double-case, barrel-type construction with the manufacturer's proved "unit-



type" rotor assembly. The double-case construction acts as a safeguard against leakage of volatile fluids through joints because symmetrical design provides greater strength and minimizes thermal distortion. Because the I-R charge pump is designed and constructed of materials to withstand heavy-duty service, the

"You have to accept the world as it is, Mac. Some of us were meant to get ulcers and some of us were meant to give ulcers."

RED SEAL RUGGEDNESS

AND

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are helping to build product acceptance for leading builders of

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Ingersoll-Rand compressor operating paving breaker. Power: Continental.

In design, in materials, and in lasting performance, Continental Red Seal engines give you the benefit of 57 years' aggressive engineering. Traditional Red Seal ruggedness finds its natural reflection in rock-bottom upkeep costs. You find Continental-powered equipment on the job—wherever there's a job to be done—in excavating, ditching, concrete ripping, railway building and maintenance, and all phases of road construction. Every Continental Red Seal is not only built for the job, but backed by parts and service facilities the world over.

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ADAMS FACT FILE #2

PLANT AIR

Moisture Chief Cause of Trouble . . .

Every company today is looking for ways to offset the increased costs of labor, material, equipment and services. At a gasoline station you expect "Free Air", but in industry it is a major expense. Perhaps in your own plant, for an investment in a few minor compressed air system alterations, significant savings are possible.

Water, sludge, rust, oil and dirt in compressed air systems are prime causes of maintenance and production down-time. Water vapor condensing in air lines tends to corrode the piping. Also, water present in the piping may freeze during winter, causing serious reduction of compressed air supply. Such restrictions are often difficult to locate and thaw. This same line moisture may emulsify lube oil destroying its lubricating value and the resultant mixture has high fouling characteristics. Frequently, ice will form within the tool itself since expanding air cools the moisture . . . tool efficiency will be seriously affected.

Some of the Other Problems Created By Wet Compressed Air . . .

Wet compressed air is not only a construction and production tool problem. Faulty paint jobs, contaminated chemical and food products can often be traced to moisture laden compressed air. Waterhammer, unequal pipeline thermal expansion and line leaks also result from collected moisture. In addition, air lost through traps, and in blow-down of compressed air lines provide no useful work . . . represent a sizeable power loss.

You Can Lick Compressed Air Moisture Problem . . .

All of these hidden costs can be virtually eliminated by the installation of an Adams Aftercooler and Cyclone Separator between the compressor and receiver tank. By cooling discharge air to within 10° F. of cooling water temperature — guaranteed with Adams standard Aftercoolers — the moisture can be removed at the separator. Pressure loss is less than one-half pound on these units including the separator. In severe cases, moisture removal of over 90 per cent can be obtained by cooling the air with Adams 2° Aftercooler to within 2° F. of water temperature.

Air Filter for Final Protection at Point of Use . . .

As an added safeguard for expensive tools and equipment, an Adams Poro-Stone Air Filter should be installed just before the air is used. These filters remove all solid material picked up by the air stream. With an Adams Aftercooler, Cyclone Separator and Air Filters clean, dry, trouble-free air is supplied to your production tools. You get continuous service with minimum maintenance.

For further information on how the complete line of Adams air equipment can solve your compressed air problems, write today for your free copy of Bulletin No. 712 on Aftercoolers and Bulletin No. 117 on Poro-Stone Air Filters from the R. P. Adams Company, Inc., 209 East Park Drive, Buffalo 17, New York.

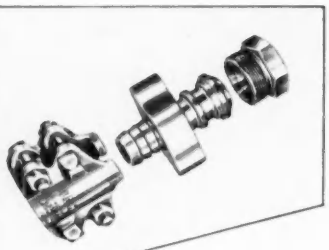
unit can be operated without a spare. For utmost reliability, the CMR is built with a forced-feed lubricated sleeve radial bearing and a Kingsbury thrust bearing. The new pump is a vertically split, double-case, multistage unit, built in 1½- and 2½-inch discharge sizes, with capacities to 400 gpm, pressures to 1500 psig and temperatures to 750° F. Further information about the features and applications of this new pump are contained in a 6-page, 2-color flier (Form 7490) available from the manufacturer. *Ingersoll-Rand Company*, 11 Broadway, New York 4, N. Y.

A PVC (polyvinyl chloride) flange union assembly is a part of Walworth's line of PVC valves and fittings. It features an O-ring seal, and reportedly provides a leak-proof joint. The assembly consists of a plain face flange, an O-ring grooved flange with a Hycar O-ring and four nuts and bolts. The fasteners are cadmium-plated as a protection against rust and corrosive atmospheric fumes. The bolts need only be finger tightened and given a part turn with a wrench, thus eliminating the tendency of overtightening with its possible consequence of scoring or breaking the union. The flange union is available in sizes from ½ through 4 inches, with threaded and solvent-weld socket-type ends in either high- or normal-impact PVC. *Walworth Company*, 750 Third Avenue, New York, N. Y.

SELF-CONTAINED plug-in compressed air dryers are available in three models to deliver a continuous supply of dry air at moisture levels ranging from minus 5° F dewpoint to minus 60° F dewpoint, measured at atmospheric pressures. Model H25AP is the standard unit and is designed for operation at air inlet temperatures to 100° F and to deliver air at levels above freezing. Refrigeration is handled by a ¼-hp air-cooled condensing unit, and because of the arrangement of the heat exchange surface, most of the refrigeration capacity is directed to moisture condensation. Model L100WP is built for low-moisture-level drying. It has a 1-hp water-cooled refrigeration unit and accom-

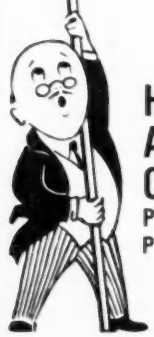
LE-HI

HOSE COUPLINGS AND CLAMPS for Air, Steam, Oil, Water, Gas



Take it from Old Doc Coupling— "LE-HI MAKES A GOOD CONNECTION for Every Coupling Need!"

WRITE FOR BULLETIN 34



HOSE ACCESSORIES COMPANY
PHILADELPHIA 32
PENNSYLVANIA

plishes drying in two stages with the bulk of the water being removed in the first stage. The moisture removed at low level is retained on the heat exchange surface as frost. The third type, Model W40, uses water in the heat ex-

changer instead of mechanical refrigeration as the cooling means. Pictured is a Model H25AP that will handle 45 scfm of air at 100-psig pressure from 95° F saturated to minus 5° F dewpoint. It is 15x15x42 inches in size. *Technical Designs, Inc.*, 119 Northfield Road, Bedford, Ohio.

TWENTY-FIVE percent more power than obtained from standard units is said to be achieved with Ingersoll-Rand's new ½-inch drive, heavy-duty electric Impactool, the Size 5U-HD. It is said that the Impactool can capably handle the toughest nuts and bolts, and that the unit is the answer to the increased requirements of assembly and mainte-

this is what it takes to give you

dependable air...

Packaged Air-Cooled Compressors—
½ through 20 horsepower
Other Compressors to 6000 Horsepower

You can't minimize the importance of a reliable source of compressed air.

Ingersoll-Rand Compressors are designed and built for maximum performance with minimum maintenance.

If your plant is in need of an air-cooled compressor in the ½ through 20 horsepower range . . . don't gamble, make sure you get the *Best*.

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HOSE COUPLINGS

For All Hose Connections

These plain rugged couplings are your surest safeguard against loss of air at the hose connections. Universal locking heads, on sizes up to 1", snap together to form a secure lock that is leakproof under pressure; in fact, pressure must be released before coupling can be disconnected. Ideal for rough outdoor work as well as indoor shop and plant service. Malleable iron, cadmium plated, and bronze. Hose Ends, Male and Female I.P.T. Ends. Size range, ¼" to 1". Also available in 4-lug type, not universal, in 1¼" to 2" sizes.

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The most efficient and economical valves for all valve stations on the system—automatically, permanently leakproof—no packing to wear out and replace—straight-line, full-flow opening through body and plug. Self-adjusting bronze plug automatically hones itself against harder steel or malleable iron valve body, maintaining a perfect leakproof seat. Proper spring tension assures constant sealing adjustment. Strong, durable construction, with handle attached to plug *within* the valve body. Male or female thread both ends, in sizes ¾" to 1½".

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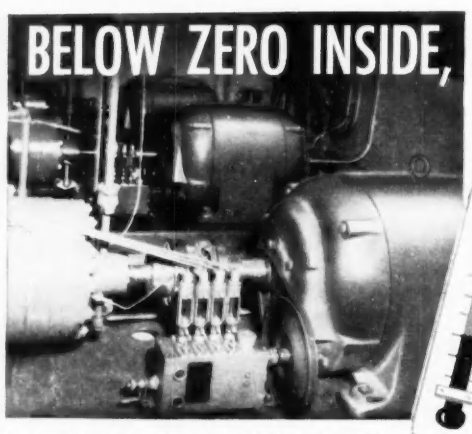
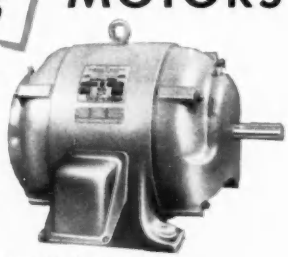
nance work. In spite of its providing a power bonus, the 5U-HD is lighter in weight and easier to handle than comparable ½-inch drive electric tools. Further, the wrench's compact T-type anvil makes the time-proved impact mechanism more efficient by delivering more power per blow. Its extra strong hammer case nose is built to last, and the

rubber nose cap effectively keeps out dirt and prevents scuffing. A sturdy new socket retaining pin in the square driver is hardened for long life; positive retention also allows easy replacement without special tools. The Impactool's dirt resistant, heavy-duty switch is totally enclosed for trouble-free service. Steel inserts in the housing provide greater gripping area for the screws that hold the hammer case to the motor housing. The 5U-HD is 10¼ inches long and weighs 6¼ pounds less cable. Side-to-center distance is 1 7/16 inches. The tool delivers 1900 impacts per minute, and runs at a free speed of approximately 1900 rpm. It is available for 110- or 220-v operation ac-dc (25-40-50-60 cycle) and is approved by Underwriters Laboratories, Industrial Type. Although used primarily for nut running, the 5U-HD is also a multipurpose tool. With standard attachments which can be easily and quickly applied, it will drill, drive screws, ream, tap, brush, saw holes, etc. *Ingersoll-Rand Company*, 11 Broadway, New York 4, N. Y.

"I see Wilson will be with us 25 years soon."



Evans Packing Company, Dade City, Fla., uses Brook Motors for refrigeration throughout their plant—one of the finest in the industry. Three of seven Brook Motors are shown on vital refrigerant compressors used in freezing and storage of concentrated citrus juices—shut-downs cannot be tolerated—an ideal spot for Brook Motors. There are no finer motors built, yet they cost less than ordinary motors. Dealers and Service Centers everywhere. Send for literature.



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GREATER PROTECTION to your AIR LINE!

M-B

WHIRL-A-WAY FILTER, REGULATOR AND LUBRICATOR ASSEMBLY AND AUTOMATIC AIR TRAP (MODEL W-4)

SUCCESSFULLY USED FOR PROTECTION OF AIR VALVES CYLINDERS CONTROLS PNEUMATIC TOOLS, ETC.

The FILTER removes solids .00039 and larger. Transparent bowl provides visibility. The REGULATOR can pass large volume with an unrestricted flow and minimum pressure drop. Self-bleeding, compact.

The LUBRICATOR delivers desired volume of oil. Bowl can be refilled without shutting off air supply.

The Air Trap is automatic and eliminates manual draining.

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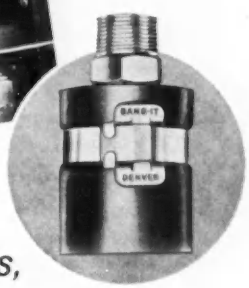
any size



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BAND-IT® CLAMPS ANYTHING!

EASIER • QUICKER • LONGER • STRONGER

Clamps of all diameters formed without waste, using only continuous roll of BAND-IT band, BAND-IT tool and BAND-IT buckles.

Band and buckles in 4 widths and 4 metals; 201 stainless steel, 316 stainless steel, hi-carbon coated steel and silicon bronze.

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Factory shipments of all four metals made to distributors in any quantity within 24 hours of receipt of order.

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Over 1500 Authorized Distributors in all principal cities of the United States and in 59 other countries.

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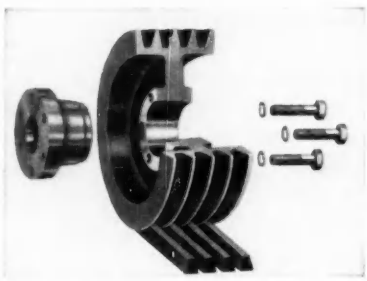

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INTERCHANGEABLE BUSHINGS . . . the most universally used type . . . easily and simply installed and removed.

MATCHED V-BELTS of unequaled dimensional stability pull together regardless of number or size.

AVAILABILITY . . . one of the widest selections of integral and fractional hp types available from stock.

SHEAVES OF SPECIAL DESIGN OR MATERIALS (SUCH AS DUCTILE IRON) WILL BE MANUFACTURED TO YOUR SPECIFICATIONS.

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NEW Power! NEW Maneuverability! NEW Unitized Construction!

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100 horsepower . . . General Motors or Cummins Diesel Engines of latest modern design.

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Up to 33,000 lbs. drawbar pull . . with adequate traction, through the Quadra-Torque-Unidrive-Torque Converter power team!

Unitized "Stress Flow" Construction . . . newest Eimco exclusive. Large, strong steel castings are molded to shape required, with thickness varied as required to withstand maximum stresses. Main frame, final drive and center housings one strong casting! No bolts or welds. Components readily accessible.

Up-front operator position . . . for maximum control and visibility.

Simple controls . . . with power shifting. No clutch. No stalling. Flip of a lever controls speeds, forward, reverse, insures more work output.

Just like your modern automobile, the modern Eimco makes operations easier, faster and more economical . . . automatically.

Investigate the many exclusive advantages of the New Eimco 103 line of Modern Tractors

Write for specifications on any of the units in this new, modern series of tractors. Address Dept. AN - 1 — The Eimco Corporation, P. O. Box 300, Salt Lake City 10, Utah. We'll be glad to demonstrate the unit that best fits your needs right on your own job, upon receipt of a request on your letterhead.

No other machine can surpass Eimco's rugged custom-built construction. Let us demonstrate the modern Eimco 103 and the famous "Big E", the Eimco 105 Series, to you and your men. You'll agree that here are machines built for the job . . . tailor-made to fill your requirements with rugged long-life quality in every component.

Want all the facts? For comparative fact sheet, listing the vital statistics of all leading makes of tractors and front end loaders, write on your letterhead to Dept. AN - 2, P. O. Box 300, Salt Lake City 10, Utah.

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to give you an ANNUAL DIVIDEND on your PAYROLL DOLLARS

NEW *DESIGNS SPEEDS POWER*

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4S Series Grinder

60% more output . . . for $3000 Dividend Dollars/year.

NEW

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25% more output . . . for $1250 Dividend Dollars/year.

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42F Series Grinder

25% more output . . . for $1250 Dividend Dollars/year.

NEW

2G Series Grinder

17% more output . . . for $850 Dividend Dollars/year.

If your operators are using older model grinders, you can increase their man-hour productivity by as much as $3000 Payroll Dollars in one year, just by replacing the older tools with one of the new I-R designs.

Multiply these *Annual Dividends* by the number of grinder operators in your plant, and you can see why management today is taking a new look at portable tool operations.

There's a fast, easy way to calculate the amount of *Dividend on Payroll Dollars* these new I-R grinders can help you earn in just one year—without adding to your present payroll.

It's yours without obligation. To get it, call your I-R AIRengineer today. Or write Ingersoll-Rand, 11 Broadway, New York 4, N. Y.

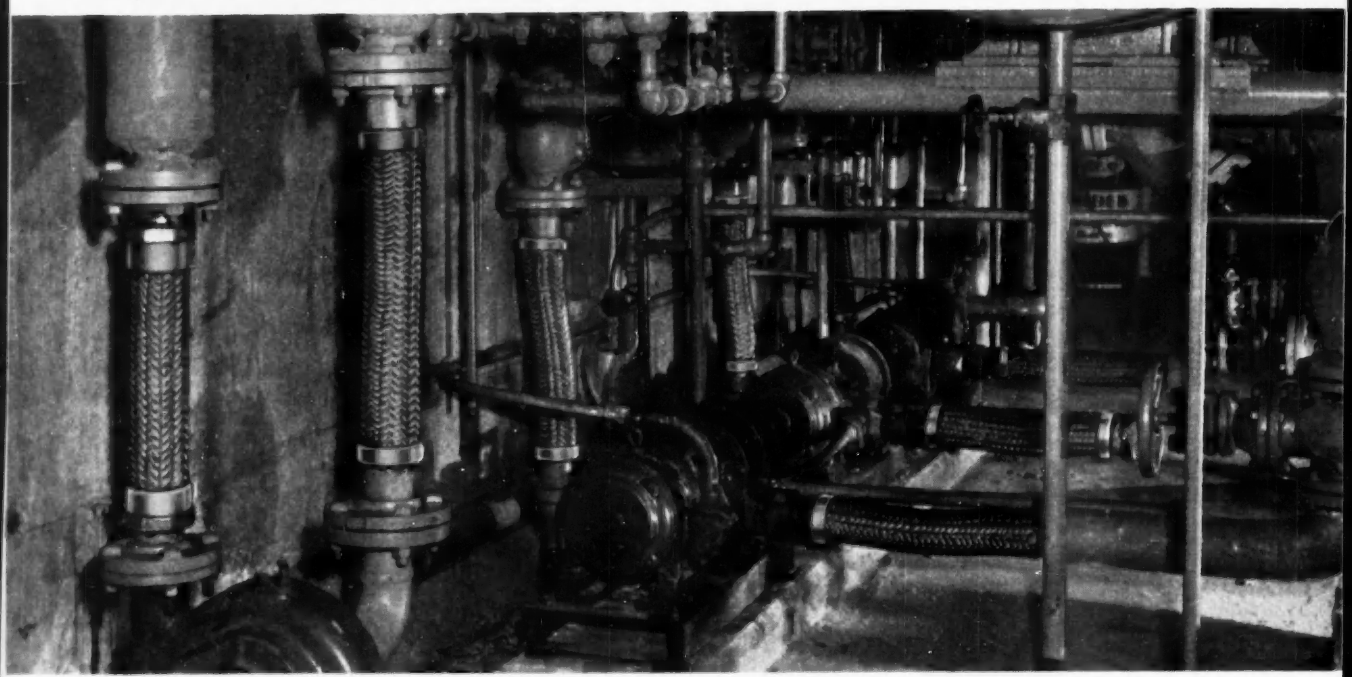
Ingersoll-Rand

Tools plus AIRengineering increase output per man

8-923

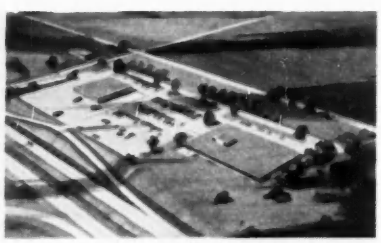
APPLICATION HINTS:

Ways to simplify construction and cut costs with Flexpipe



Six Flexpipe connectors, 2½" I.D., 24" long, at the three boiler feed pumps. In the foreground are the Flexpipe connectors at the hot water pump feeding Weathermaster units throughout the Administration Building of the Illinois State Toll Highway Commission.

Flexpipes made this heating and cooling system more compact, cut installation time



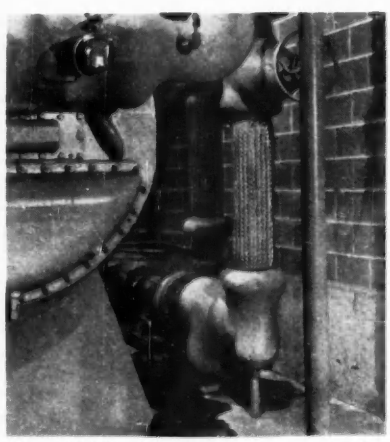
Artist's rendering of the Administration Building, Illinois Toll Highway Commission. Lankton, Ziegele, Terry & Associates: Architects and Construction Engineers.

Heating and cooling systems can utilize all the advantages offered by Flexpipe connectors. Flexpipes take up movement caused by expansion and contraction in piping from wide variations in temperature. At the same time, they absorb vibration and dampen noise from pumps.

They make possible better utilization of space because they are easier to install in tight quarters and can handle offset. Note in photo above how vertical Flexpipes from boiler feed pumps saved space by making possible easy connections to piping flush against wall. Conventional piping would require considerably more work room—plus the time and cost of installing elbows, couplings, short runs of pipe, etc.

Flexpipe's flexible core can be either bronze, galvanized steel or stainless steel—I.D.'s range from ¼" through 16".

WHERE TO BUY: Leading wholesaler distributors can provide you with information about Flexpipe in standard sizes. For the name and address of the distributor serving your area, or for more detailed information, write to: Anaconda Metal Hose Division, The American Brass Company, Waterbury 20, Connecticut. In Canada: Anaconda American Brass Ltd., New Toronto, Ont.



Two 8" I.D. Flexpipe connectors handle cooling water for refrigeration unit.

Flexpipe®

an

ANACONDA®

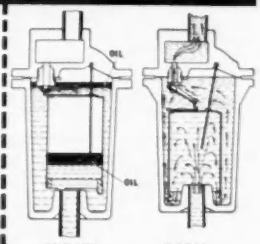
product

OIL WON'T STOP UP THIS AIR TRAP

Oil from heavy-duty compressors clogs ordinary ball-float traps—but not an Armstrong inverted bucket trap. The diagram at right shows how it handles even heavy oil.

(Warning—even an Armstrong will not handle oil-water emulsions described as "warm peanut butter".)

- **Handles Dirt**—No dead spots for dirt to collect. Dirt stays in suspension, won't settle on valve or seat—they're at top of trap.
- **Trouble-Free Construction**—Stainless steel working parts; heat-treated chrome steel valve and seat, lapped to a precision fit.
- **Flexible Instalation** Installs above or below unit being drained, because of air bleed. Slight air loss (7-10 cu. ft./hr.) costs only about a penny a day, figuring air at 6¢ per 1000 cu. ft.
- **Low Cost, High Capacity**—On a size for size basis.



CLOSED OPEN

How It Works

CLOSED: Oil collects on top of water in trap. Air in trap floats bucket. Valve held closed by pressure.

OPEN: When water displaces air in bucket, bucket sinks, pulls on lever and opens valve. Oil floats out along with condensate.

SEND FOR BULLETIN

Bulletin No. 2024 shows how to select air traps for any job. Also gives complete data on all Armstrong air traps. For a copy, call your local Armstrong Representative, or write:

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THAT HELPS SELL THE COMPRESSOR!

Specify

SQUARE D PRESSURE SWITCHES

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- Easy wiring
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- Available with or without release valve
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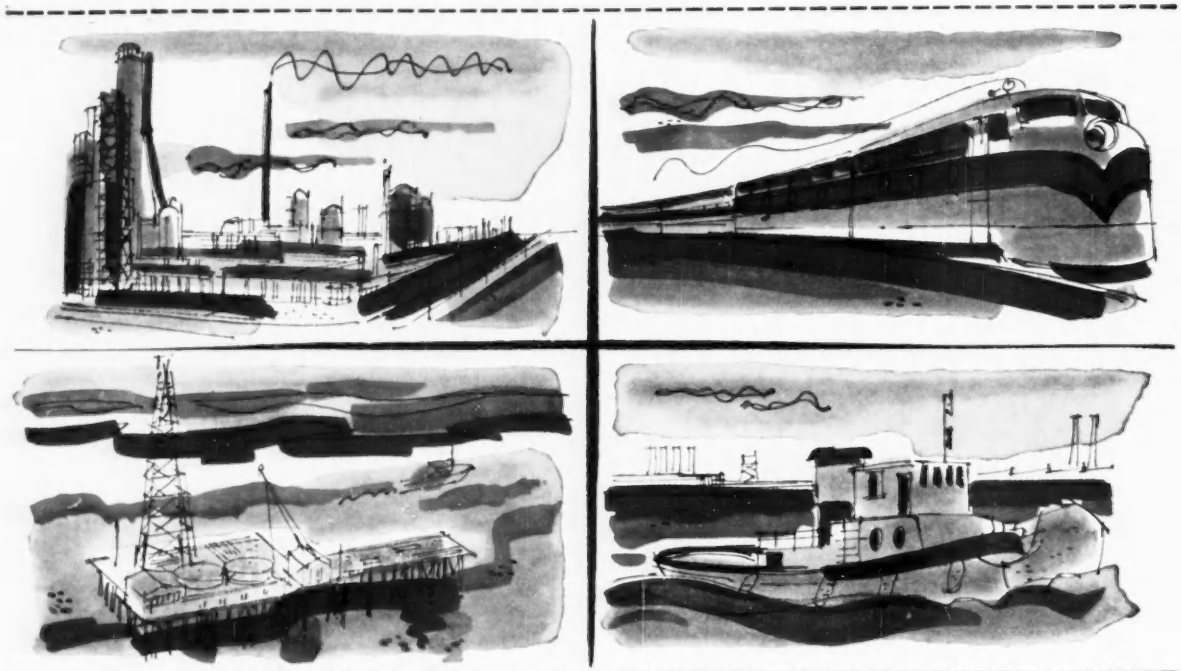

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Since the first diesel engine, Koppers has produced piston rings of predictable performance in a complete range of materials and a wide selection of types and sizes. If you have a ring problem, Koppers can offer you the benefit of their experience. Write to: KOPPERS COMPANY, INC., Piston and Sealing Ring Department, 4107 Hamburg Street, Baltimore 3, Maryland.

Send now for Koppers recommended Piston Ring Set-Ups applicable to the engines which you operate.

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BALANCED ENGINEERING

keeps trucks on the move

How can you be *sure* of high production? Consider this: *more quarry and mine operators depend on Bucyrus-Erie electric shovels than any other.* Performance on the job proves that they are more rugged, stay on the job longer, require less service and maintenance.

Behind this kind of performance is Bucyrus-Erie *Balanced Engineering* . . . engineering that makes sure that all components are soundly designed, soundly built. The voltage control system is an example. It delivers fast acceleration and deceleration the instant you need it . . . gives you high torque at low speeds, high speeds at low torque . . . and is designed to be *consistently dependable.*

For the complete story on *Balanced Engineering,* write Bucyrus-Erie Company, South Milwaukee, Wisconsin, Dept. 21A.

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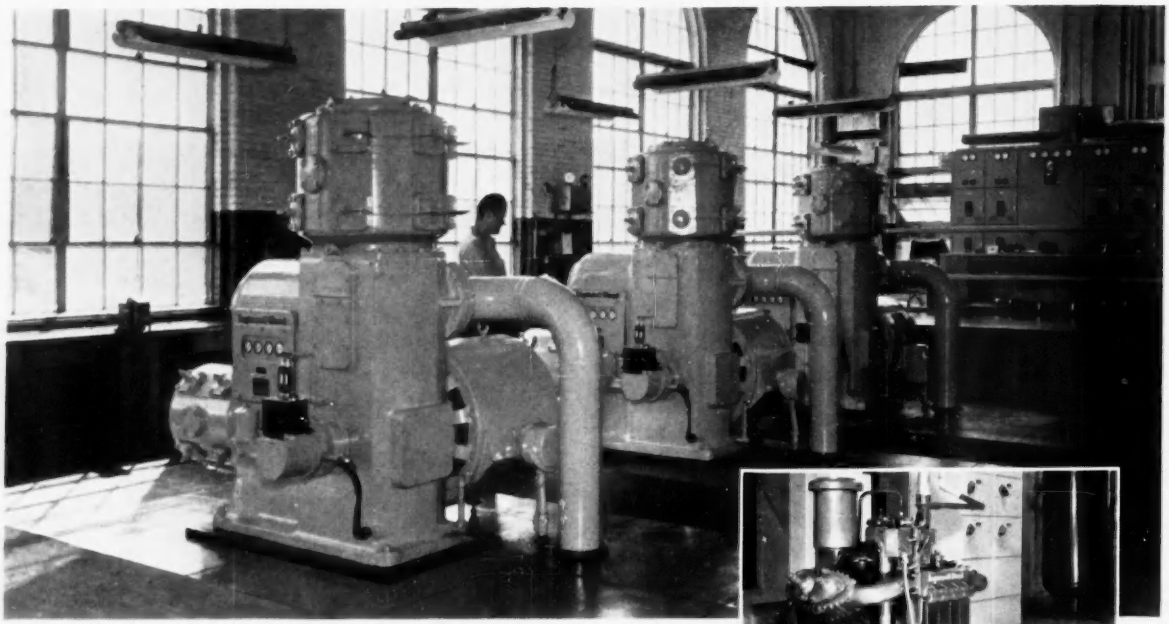
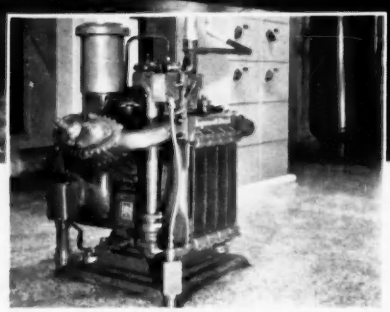
How to squeeze more profits out of your COMPRESSED AIR POWER



Three 125-hp XLE compressors generating air power for a weapons plant. This compact two-stage unit features pipeless Thru-Frame air flow and full-floating aluminum bearings which never need adjustment. Sizes 125 to 350 hp. (Other I-R air compressors to 4000 hp.)



This air-cooled two-stage Type 40 compressor is one of several furnishing plant air and instrument air in a power plant. Sizes 25 to 125 hp. (Others from ½ hp.)

Make sure you have enough pressure at point of use—and extra dependability at point of generation

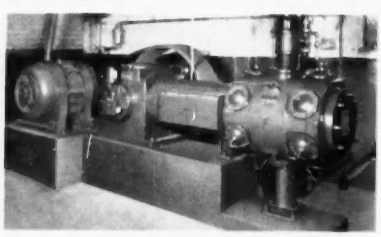
Cost-conscious plant engineers and production men know that to get the full savings inherent with air-powered equipment, you must have full air pressure at every tool.

But it's equally important to guard against unscheduled shutdowns where your air power is generated. This problem can best be solved at the time of purchase, by specifying compressors that have an extra margin of safety against mechanical troubles.

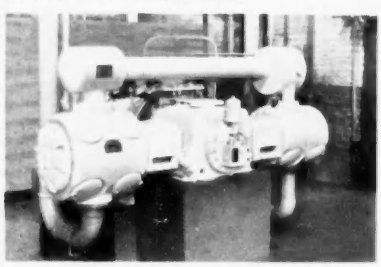
Ingersoll-Rand compressors have that extra safety margin built in. They'll stay on the job longer, with minimum attention and maintenance. Take valves, for example—the most "vulnerable" point in any compressor. Only I-R compressors have Channel Valves, known the world over for efficiency, quiet operation and long life. Their exclusive air-cushioned action eliminates impact and greatly reduces wear.

Also in I-R compressors, all running parts are sealed against dust and dirt which might cause wear. The seal need never be broken, since bearings are a type which will never need adjustment.

For top compressor performance and long-run economy, specify Ingersoll-Rand. And ask your I-R representative to show you how to get your maximum *"Dividend on Payroll Dollars"* with a Planned Annual Review of your air power system.



Ingersoll-Rand's new ESH horizontal compressor, here in a tool factory. Sizes 20 to 150 hp. Also built as vertical unit, called ESV.



Two-stage balanced-opposed PHE compressor handling air in a gas plant. Also built as L-design unit with packaged intercooler. Sizes 75 and 100 hp.

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